(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

JANUARY, 1907.

2-8 2 TYPE ELECTRIC LOCOMOTIVE.

NEW YORK CENTRAL LINES.

During the past month the New York Central & Hudson River Railroad Company has started partial electric train service on what is known as the initial electric zone extending from the Grand Central Station, New York, to High Bridge, a distance of 7.1 miles on the Hudson Division and to Wakefield, a distance of 12.5 miles on the Harlem Division. This service employs electric motor cars and trailers for the suburban trains and powerful electric locomotives for the express trains. Direct current of 650 volts, supplied ordinarily through an under contact third rail and through overhead contact at cross overs, road crossings, etc., is used.

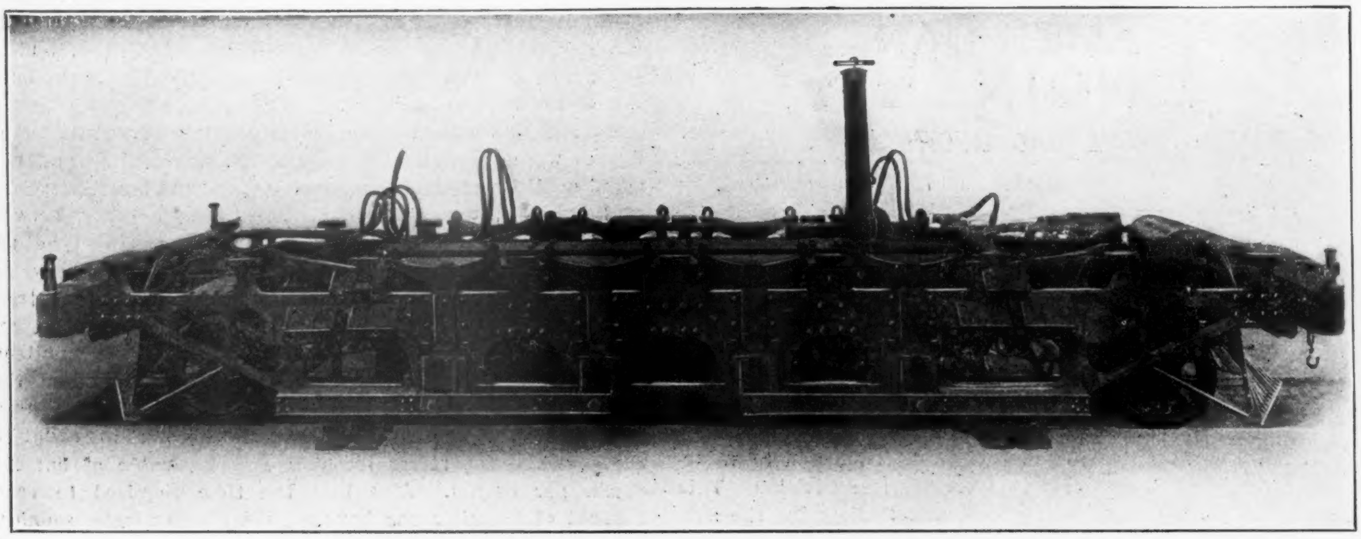
The electric locomotives, 35 of which have been received, were built by the General Electric and American Locomotive Companies, and are considerably more powerful than any steam passenger locomotives now in high speed service. They weigh 200,500 lbs. total, of which 142,000 lbs. is on the four pairs of driving wheels. The tractive effort is 34,000 lbs., giving a ratio of 1 to 4.18 with the weight on drivers and 1 to 5.9 with the total weight. The normal horse power which can be developed is 2,200 or 550 h.p. per motor. This, however, can be increased to 3,000 h.p. at starting or for short intervals in running. The motors are of the gearless type, the armatures being mounted directly upon the axles of the driving wheels. The specifications call for a maximum speed of these locomotives of from 60 to 65 miles per hour, which with the 44 in. driving wheels, will give about 460 r.p.m. of the motors. This speed is to be made with a 500 ton train. For trains of greater weight two of the locomotives can be coupled together and operated on the multiple unit system.

The first experimental locomotive of this type, which was No. 6,000, was finished about two years ago, and was put into service on a short experimental section of track near Schenectady, where very complete service tests were made of all its features. This locomotive was run for a total distance of 50,000 miles under all weather conditions, and all the weak points were discovered and remedied before the building of the first order of 35.

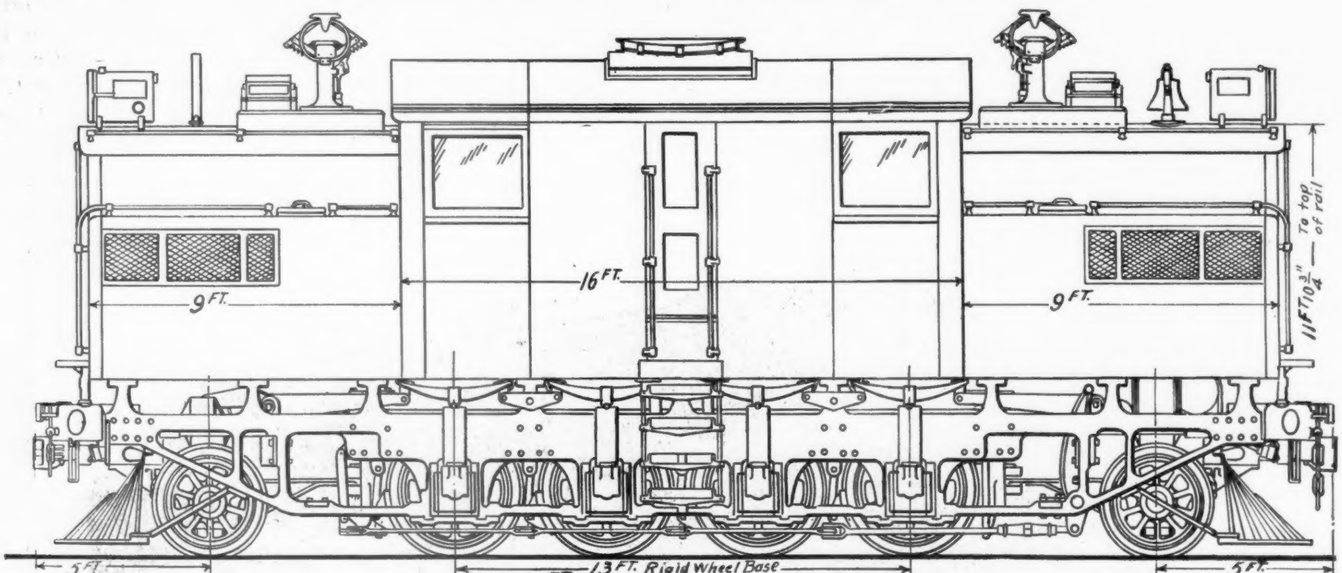
During this experimental service some very satisfactory figures were obtained in respect to the acceleration and high speed qualities of the locomotive. One of the most interesting of this series was an actual competition, or race, between electric locomotive No. 6,000 and a large Pacific type passenger locomotive, which had approximately the same weight on drivers, both locomotives hauling the same weight train. A series of runs with varying conditions were made, and an account giving the conditions and results was published in this journal June, 1905, page 225. It was found at that time that the electric locomotive was capable of an acceleration of .394 miles per hour per second to about 50 m.p.h., while the steam locomotive was capable of but .246 m.p.h. per second. Also that the time required to reach a speed of 50 miles per hour with a six car train weighing 407.5 tons for the electric and 427 for the steam, was about 127 seconds, for the electric and 203 seconds for the steam. These figures clearly show wherein the biggest advantage from an operating standpoint of the electric service lies. Also during this series of tests the electric locomotive was capable of attaining over 85 m.p.h. when running light, although in this connection it must be understood that these machines were not designed for specially high speeds. Accurate figures were also obtained on the cost of operating and maintaining the electric locomotives, which in spite of some unusual accidents, among which was the burning of the shed in which the locomotive was housed, were, as compared with similar figures for the steam locomotive, very low.

ELECTRIC PASSENGER LOCOMOTIVE, NEW YORK CENTRAL LINES.

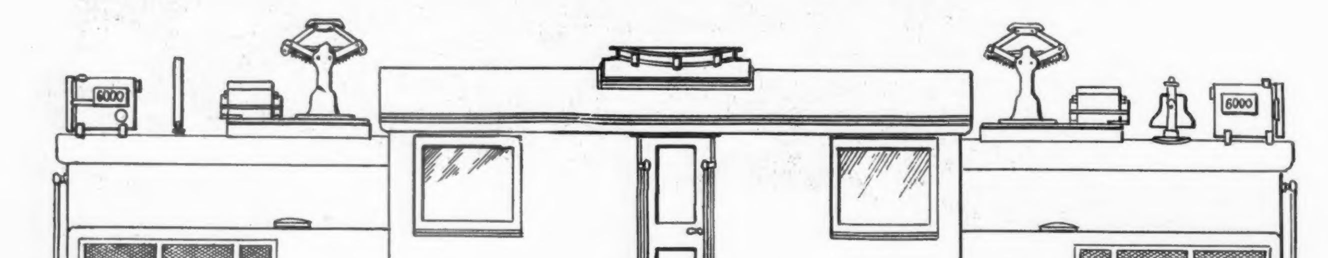
The illustrations give a clear idea of the general structure of the locomotive, and it will be noted that many features of steam locomotive design have been incorporated in this machine, notably the fact that the power is transmitted from the drivers through the two main frames to the end casting, in which is located the draft gear. The cab is simply superimposed on these frames and is built of light structural steel shapes and plates. The side frames are outside of the driving wheels and are made of cast steel. They extend continuously from end sill to end sill and have the driving boxes fitted into pedestals in the ordinary manner, there being a difference from steam locomotive practice



UNDERFRAME AND RUNNING GEAR OF ELECTRIC LOCOMOTIVE, NO. 6000.



SIDE ELEVATION OF NEW YORK CENTRAL ELECTRIC LOCOMOTIVE.

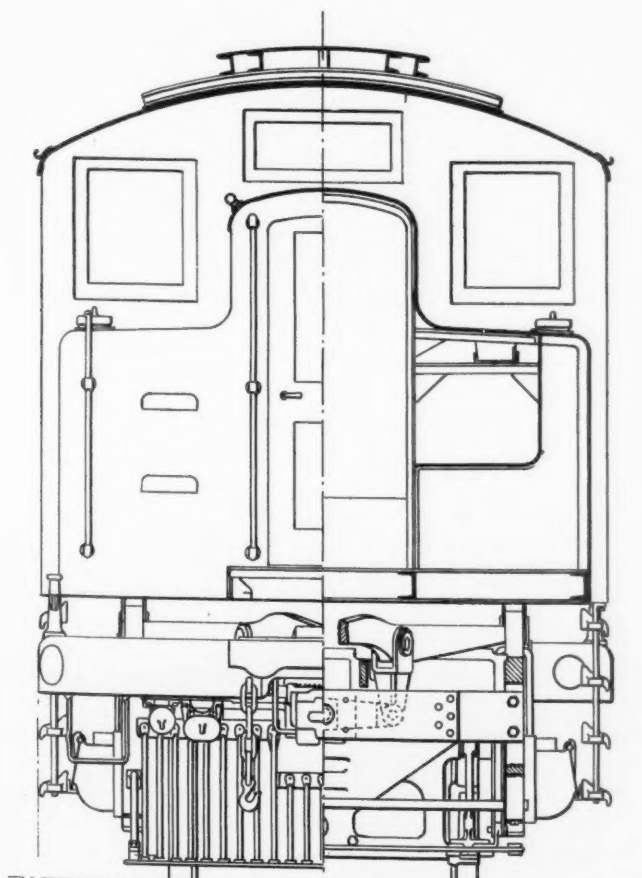


SECTION THROUGH MOTORS, NEW YORK CENTRAL ELECTRIC LOCOMOTIVE.

in that there are no wedges, both pedestal jaws being fitted with cast iron shoes. The end frames are heavy steel castings securely bolted to the side frames and are fitted with pockets for the draft gear and platform springs. In addition to these there are five transverse steel castings, or cross ties, fitted and bolted to the side frames, there being one between each pair of drivers and one at either end just outside of the driving wheels. These transverse castings support the field magnets of the

motors, the three centre ones supporting a coil on either side and the end ones supporting a coil on the inner side only and having lugs on the opposite side for attaching the pony truck radius bar. The pony trucks, of which there is one at either end of the locomotive, are of the usual locomotive design.

The springs and equalizers are placed above the frame, there being a sem-elliptic spring, resting by means of the saddle on top of each driving box. The first and second pair of drivers are equalized together with the pony truck on that end, there being a difference, however, in the two ends of the locomotive, which is partially shown in one of the illustrations, in that the two equalizers of the pony truck at one end are themselves fulcumed on the ends of a short transverse equalizer, thus forming a system which gives a three point suspension to the locomotive. Above the cast steel cross ties there are two longitudinal steel pieces of about 36 sq. ins. in section which are so located with reference to the centre line of the locomotive as to equalize the uneven balance caused by the necessary off-setting of the armature on the axle and consequently of the field coils. These longitudinal pieces are also of value in forming part of the magnetic circuit of the motors.



END ELEVATION AND SECTION, ELECTRIC LOCOMOTIVE.

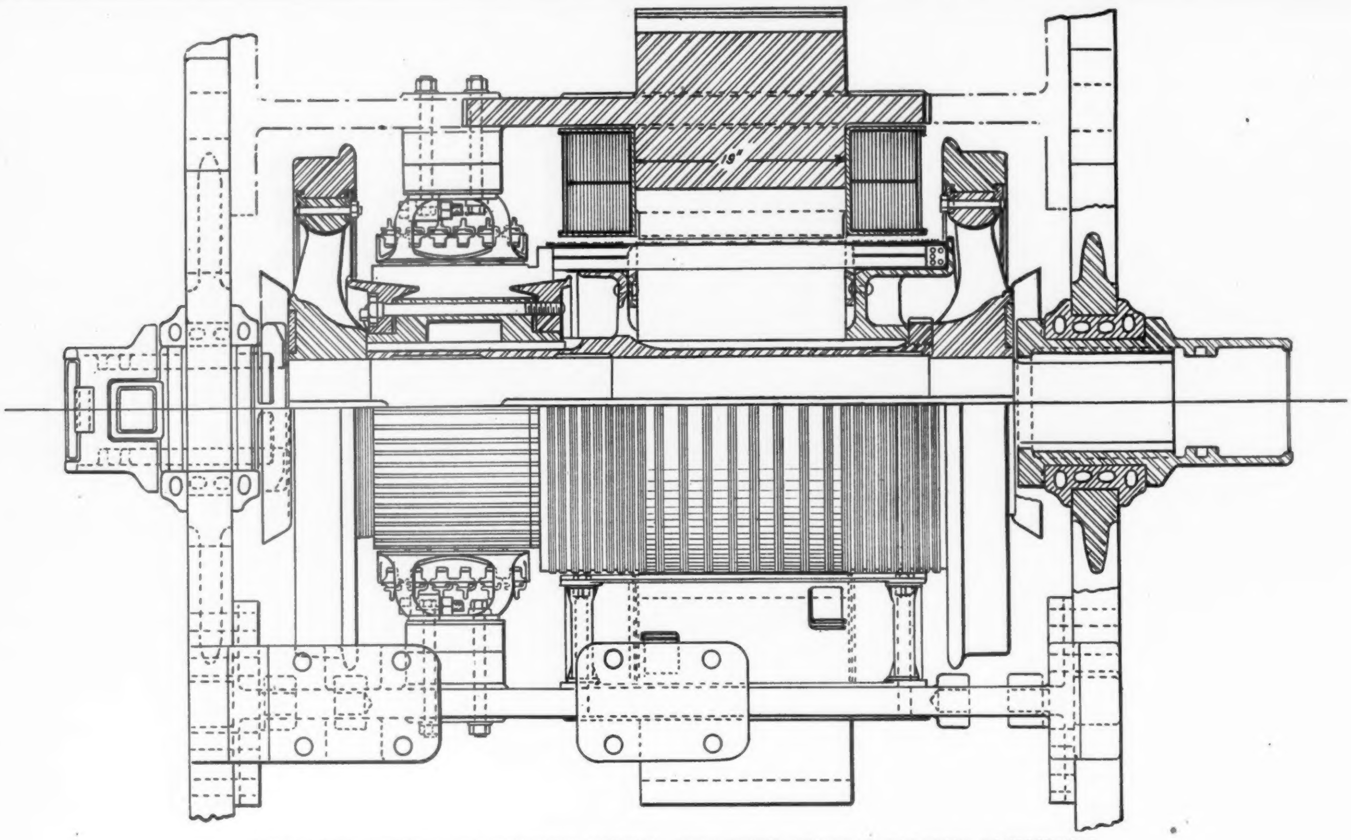
The central portion of the superstructure or the cab proper, consists of a large open room in which are located the motorman's controlling apparatus, which is in duplicate, one set at each end; the electric air pump, and also a space in which eventually will be installed a boiler for steam train heating. One of the illustrations gives a view of the interior of the cab, showing the location and arrangement of the apparatus.

VIEW OF INTERIOR OF CAB, ELECTRIC LOCOMOTIVE.

It is about 16 ft. long, by 9 ft. wide and from it extends an alleyway or corridor leading to a door at either end. On either side of this corridor are placed the rheostats, contactors and switches of all kinds. The section containing this apparatus, while of the full width of the locomotive, is made low enough to give an unobstructed forward and rear view from the cab windows. Careful attention to details is noticed in the construction of the cab and by means of butt joints in the plates and careful finish, the exterior presents an excellent appearance. In the interior special care has been given to prevent any possibility of accident and all conductors are not only heavily insulated, but also carried in pipes whereever possible.

The convenient arrangement of the motorman's control apparatus is shown in the interior view of the cab. When seated on the ordinary drop seat of locomotive type the motorman has at his right a large sliding window and ahead a double sash window, the lower sash of which can be swung out and adjusted at any angle. At his left is the main controller with a long lever, resembling a throttle lever, in a position easily reached when leaning out of the side window. Immediately in front, below the front window, is located the engineer's brake valve, alongside of which is the air guage. Within easy view are also located a volt and ammeter. To his right just below the side window is the valve controlling the raising and lowering of the trolleys, which are operated by air pressure and just behind him is a valve for the air sanders. A bell rope and whistle cord are within reach and two electric heaters are located on the front wall near the floor. All guages are illuminated by shaded lamps. The switches for electric headlights, cab light, etc., are in the corridors.

The current is collected from the third rail by four shoes of the design shown in one of the illustrations. These are carried from wooden blocks fastened to the locomotive frames, and are spring supported and arranged for a vertical play of about 2 ins. They are adapted for making contact with either over or under running third rails. There are also two pantagraph type sliding trolleys, mounted on top of the locomotive for collecting current from overhead rails when



PLAN AND SECTION OF GEARLESS MOTORS, NEW YORK CENTRAL ELECTRIC LOCOMOTIVE.

END ELEVATION AND SECTION OF GEARLESS MOTORS, ELECTRIC LOCOMOTIVE.

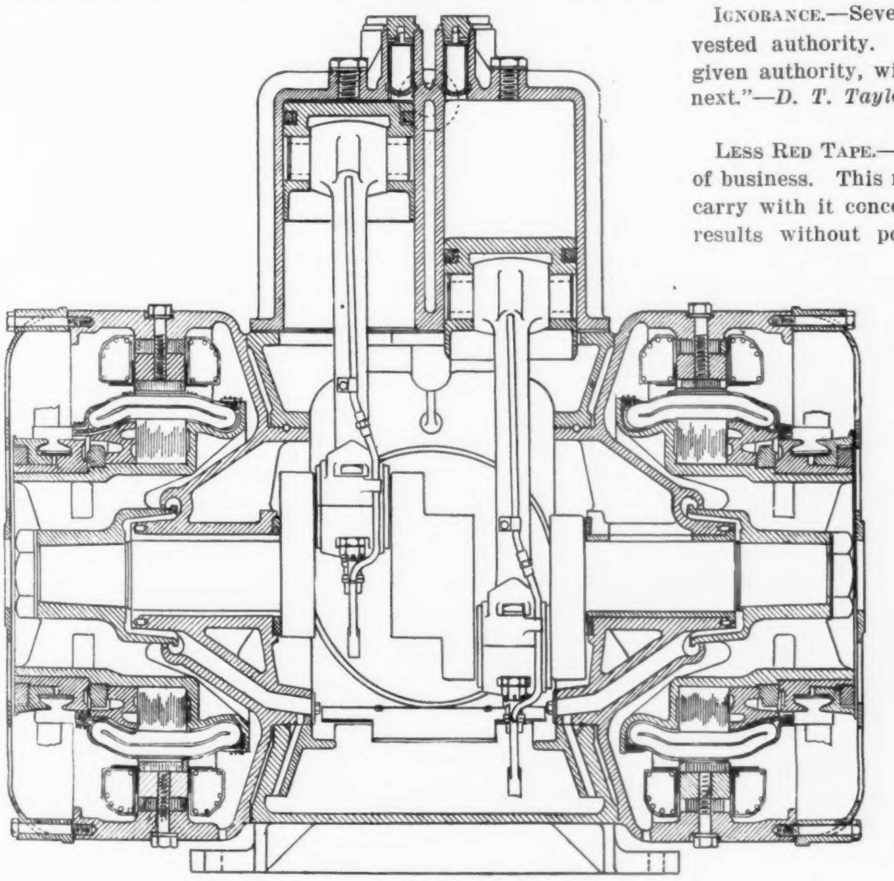
necessary. These are raised and lowered by air pressure. Both the shoes and trolleys have a fuse placed in boxes lined with fireproof material and located on the outside of the locomotive, close to the point of contact.

The motors are two pole direct current series wound and are rated at 550 h.p. each. They are built to withstand an over-load of 50 per cent. for one hour, with a rise of temperature not to exceed 75 degs. The pole faces are made practically flat so that the driving wheels with the armature can be removed by means of a drop pit without disturbing the field coils. The core of the field coil, as above mentioned, is integral with the steel cross ties, the faces being made up of laminated soft iron sections dovetailed into the cast steel cores and held in position by the field coils.

The brush holders are mounted on insulated supports secured to a lug cast on the frame cross ties, and are arranged to allow a considerable degree of vertical adjustment. This construction, as well as other features of the motor, are clearly shown in the illustrations of the cross sections through the motors. It will be seen that since the armature is rigid on the drivers and the field coils and brushes are carried on the frame that there will be at all times considerable vertical movement between these parts and hence all parts of the motors are arranged to suit. The air gap between the armature and pole face is nominally ¼ of an inch.

The Sprague-General Electric multiple unit system of control is used on these locomotives, and the motorman's controller located in the cab is the master controller for operating the contacts located in the end portions of the superstructure. Notches on the master controller, however, correspond directly to the different contacts on the main controller, and are divided into three general sections. The first section connects all four motors in series together with a certain amount of resistence and for each notch of the controller in the first group, parts of this resistance are cut out until the four motors are connected in series directly across the terminals. The next group at the first notch connects the motors in groups of two motors, which are in series, the two groups being in multiple with resistance in

the circuit. As the handle is still further pulled back, each notch cuts out more resistance until it has all been cut out. The controller then passes to the third group, where all motors are connected in multiple, there being at the first notch of this group resistance in the circuit, which resistance is again gradually cut out until finally at the last notch the motors are given the full amount of current when connected in multiple. The resistance consists of flat grids of cast iron mounted in cast iron frames from which they are insulated. The connection to the controller contacts is made by heavy copper bars. Cast iron is used for resistance because it is cheaper, has a high specific resistance and will stand a large amount of heat before any danger of short circuiting. In order to prevent burning out the motors by too rapid reduction of resistance in the circuit before they have come to speed, there is an electrical arrangement in the controller, which prevents it being moved to another notch before the motors have reached the proper speed. It is also



SECTION OF ELECTRIC AIR PUMP.

impossible to move the controller handle unless the reversing lever is fully thrown either forward or backward, this prevents burning out, caused by the controller handle being in a mid position before the current is thrown on by the reversing lever.

For the air brake and other pneumatic devices there is located in the cab, a double cylinder air compressor driven by two general electric 600 volt series motors. The appearance of this compressor is shown in one of the illustrations, and its construction is made clear by the cross section. It has a capacity of 75 cu. ft. of free air per minute, and is controlled by a governor, which automatically cuts the motors in and out of the circuit when the air pressure falls below 125 lbs. or exceeds 135 lbs.

Electric headlights are mounted on either end of the locomotive and behind them on one end is a regular locomotive bell, operated by either a cord or by a pneumatic bell ringer, and on the opposite end is an air whistle. The end upon which the whistle is located, and toward which the brake rod pushes is called the "A" or front end of the locomotive. No attention, however, is given to this in the direction of operation.

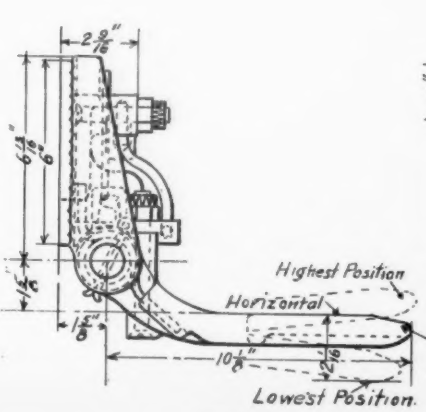
The table of general dimensions and weights follows:

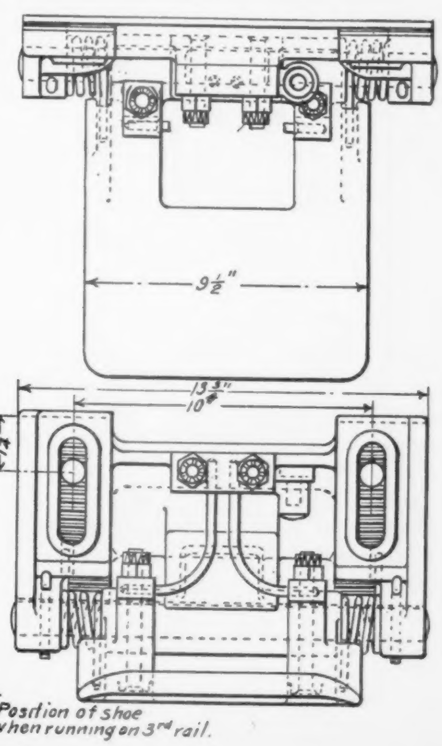
No. of driving wheels	8
Total weight	200,500 lbs.
Weight on drivers	142,000 lbs.
Total wheel base	27 ft.
Driving wheel base	13 ft.
Diameter of drivers	44 in.
Diameter of truck wheels	36 in.
Diameter of driving axles	8.5 in.
Total length	37 ft.
Extreme width	10 ft.
Height to top of cab	14 ft. 4 in.
Normal rated power	2,200 h.p.
Maximum power	3,000 h.p.
Tractive effort	34,000 lbs.
Voltage of supply current	650 v.
Normal full load current	3,050 a.
Maximum full load current	4,300 a.
Type of motors	G E-34-A.

IGNORANCE.—Seven times out of ten, ignorance will abuse vested authority. The technical graduate as a beginner, if given authority, will display many forms of ignorance. "Get next."—*D. T. Taylor, St. Louis Railway Club.*

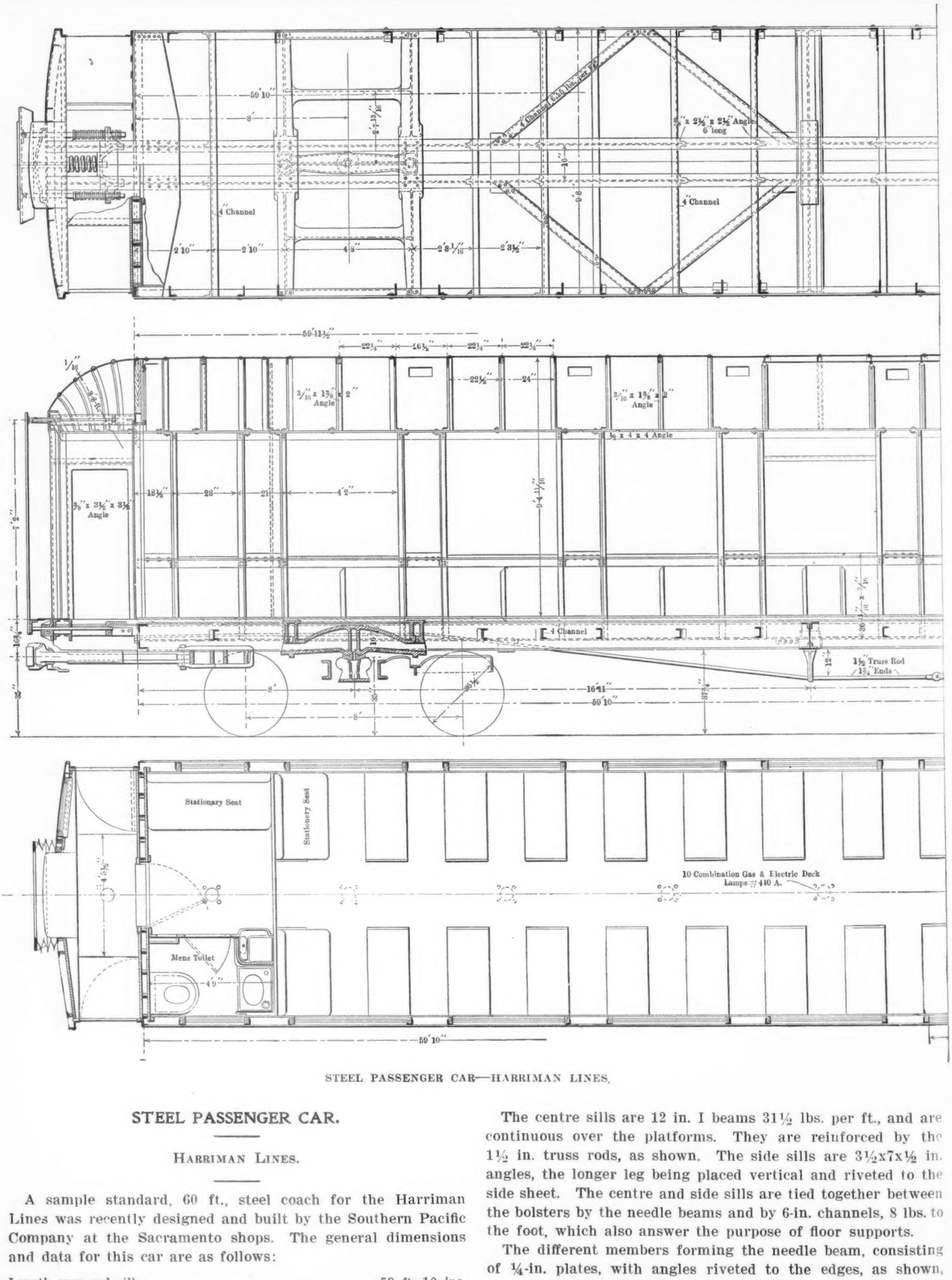
LESS RED TAPE.—First consider directness, which is the staff of business. This means that concentrated responsibility must carry with it concentrated authority. A man cannot produce results without power to remedy existing conditions. The path of the statement of net results should be the direct return path of the appropriation. But should this path in most cases lead clear to the vice-president's desk, or even the general manager's? It ought to be possible for an official to show a correctly figured plan for effecting economies to his superior and get the authority for expenditure therefor.—*Paul R Brooks, before the New York Railroad Club.*

The officer who can smile as he comes in contact with those under him is best fitted to make those who neglect their duty tremble, since when he does look serious there is no question as to the seriousness of the offense.





THIRD RAIL SHOE, ELECTRIC LOCOMOTIVE.



STEEL PASSENGER CAR—HARRIMAN LINES.

STEEL PASSENGER CAR.

HARRIMAN LINES.

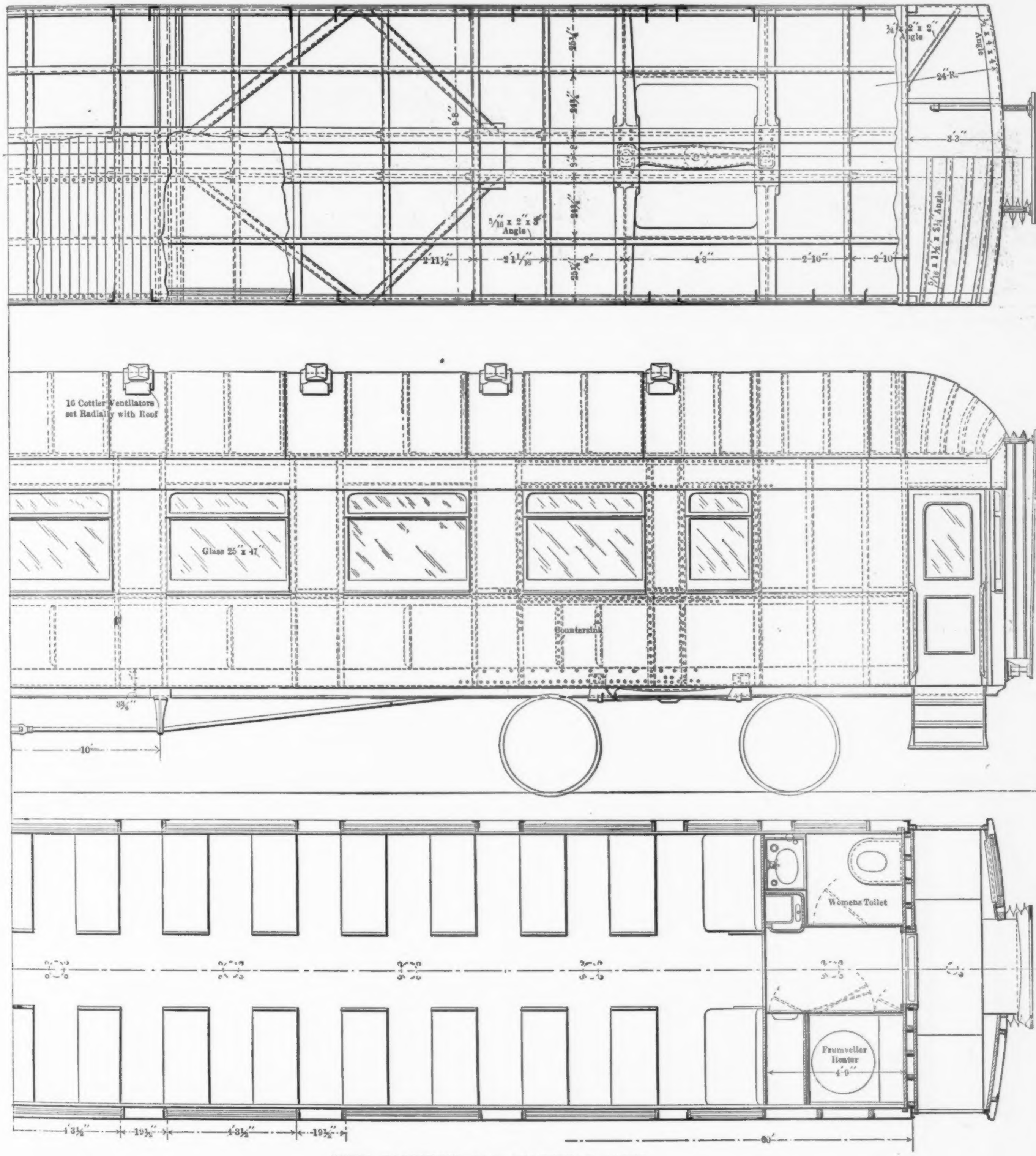
A sample standard, 60 ft., steel coach for the Harriman Lines was recently designed and built by the Southern Pacific Company at the Sacramento shops. The general dimensions and data for this car are as follows:

Length over end sills	59 ft. 10 ins.
Distance between inner faces of coupler knuckles	67 ft. 10 ins.
Distance from centre of body bolster to outside of end sill	8 ft. 10 ins.
Width over side sills	9 ft. 8 ins.
Width over eaves	9 ft. 8½ ins.
Height top of rail to top of roof	13 ft. 8¼ ins.
Seating capacity	70
Weight of car body	75,500 lbs.
Weight of trucks	31,500 lbs.
Weight, total	107,000 lbs.
Wheels, diameter	36½ ins.
Journals	5 x 9 ins.

The centre sills are 12 in. I beams 31½ lbs. per ft., and are continuous over the platforms. They are reinforced by the 1½ in. truss rods, as shown. The side sills are 3½x7x½ in. angles, the longer leg being placed vertical and riveted to the side sheet. The centre and side sills are tied together between the bolsters by the needle beams and by 6-in. channels, 8 lbs. to the foot, which also answer the purpose of floor supports.

The different members forming the needle beam, consisting of ¼-in. plates, with angles riveted to the edges, as shown, are secured to the sills, and are in addition tied together by the ½x9 in. plate riveted to the angles at the bottom, and extending the full width of the car and by the ¼x7 in. top cover plate.

The 6-in. channels, 8 lbs. per ft., which tie the sills together and carry the longitudinal floor supports are fastened to the centre sill by ⅜x2½x2½ in. angles, and to the side sill and



STEEL PASSENGER CAR—HARRIMAN LINES.

posts by angles and gussets, as shown in the drawing. The diagonal braces are 4-in. channels, $5\frac{1}{4}$ lbs. per ft.

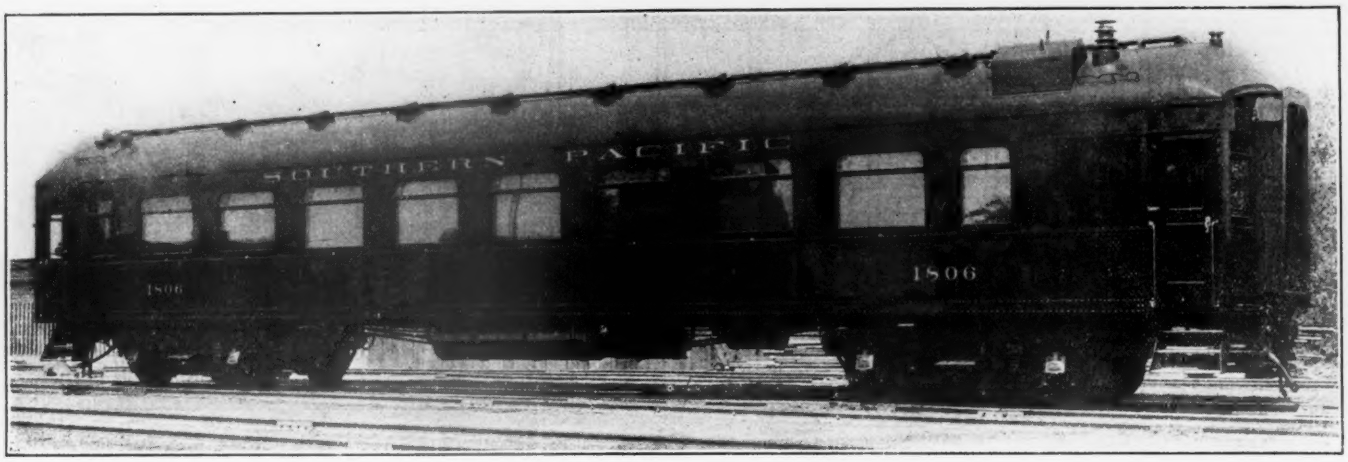
The body bolsters are double and of cast steel. The end sills consist of a $\frac{1}{2}$-in. plate, with $4x4x\frac{1}{2}$ in. angles riveted at the top and bottom, and with a 5-16-in. plate, 20 ins. wide at the centre, riveted to the top angle and to the longitudinal sills.

The arrangement of the steel platform and the Janney coupler attachment is shown on the drawings, except that the coupler is equipped with the standard centering device used by the company. Miner tandem spring draft gear is used.

The floor construction is as follows: The usual wooden nailing strips are not required, as they are replaced by the 5-16x2x3-in. angles, on which is placed a 1-16-in. steel plate as shown; above this is placed a layer of mineral wool, and then a $1\frac{1}{2}$-in. layer of Oregon pine, T and G, 3-in. face. Above this wooden flooring is placed a 1-16-in. steel plate, a 1-16-in. layer of asbestos and a $\frac{3}{8}$-in. thickness of linoleum.

The side posts are $\frac{3}{8}x2\frac{1}{4}x4$ in. angles, with strips of $1\frac{1}{8}x$ 4 1-16 in. yellow pine, bolted to them for securing the inside finish and window sash. The ends of the posts are bent to fit the side sill and side plate angles. The belt rails are $\frac{3}{8}x2\frac{1}{4}x4$ in. angles fitted between the posts and riveted to them.

The side of the car below the windows is covered with 3-16-in. steel plate, riveted to the posts and butt jointed in three places to permit convenient handling of the plates. Between the windows $\frac{1}{8}$-in. plates are riveted to the posts, the ends of these extending under the letter board plate. The letter board is a $\frac{1}{8}$-in. steel plate. The construction of the end framing is clearly shown on the drawing. The roof carlines are $\frac{1}{4}x$ 2x3 in. angles, and are riveted to the side plate angles, and have $1\frac{1}{8}x3$ in. wood fillers bolted to them for securing the



STEEL PASSENGER CAR—HARRIMAN LINES.

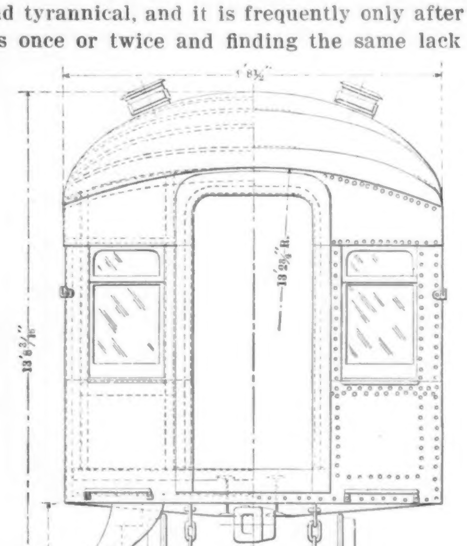
head lining. The roofing consists of 3-32 in. plates. The inside finish is of Mexican mahogany. Cottier ventilators are used. The car is heated by the Consolidated system, in conjunction with a double coil Frumveller heater, and is equipped for lighting either by gas or by the United States (Moskowitz) system of axle electric lighting.

We are indebted for drawings and information to Mr. J. J. Kruttschnitt, director of maintenance and operation of the Harriman Lines.

THE COLLEGE GRADUATE IN PRACTICAL WORK.*

Something may possibly be gained by considering what has seemed to many of the friends of our young graduates to be the one defect which they practically all have in common.

For a period of from six months to two years after graduating they are, generally speaking, discontented and unhappy. They are apt to look upon their employers as unappreciative, unjust and tyrannical, and it is frequently only after changing employers once or twice and finding the same lack of appreciation in all of them that they finally start upon their real careers of usefulness.



END VIEW, STEEL PASSENGER CAR.

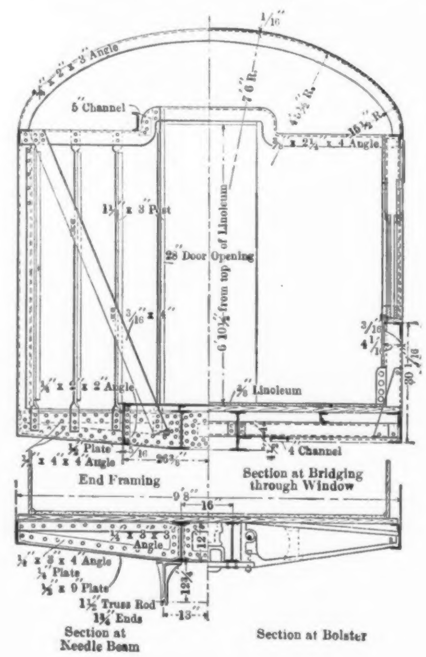
On the other hand, the attitude of employers toward young graduates is fairly expressed by the following written instructions given for the selection of quite a large number of young men to fill positions which presented opportunities for rapid development and advancement. These instructions were to give the preference—first, to graduates of technical schools; second, to the graduates of the academic departments; but to employ no college boy who had not been out for more than two years.

Why is it, then, that these young men are discontented and of practically little use during the first year or two after graduating?

To a certain extent this is unquestionably due to the sudden and radical change from years spent as boys almost solely in absorbing and assimilating knowledge for their own benefit to their new occupation of giving out and using what they have for the benefit of others. To a degree it is the sponge objecting to the pressure of the hand which uses it. To a greater degree, however, I believe this trouble to be due to the lack of discipline and to the lack of direct, earnest and logical purpose which accompanies, to a large extent, modern university life.

During the four years that these young men are at college they are under less discipline and are given a greater liberty than they have ever had before or will ever have again.

As to college discipline, it cannot be a good training for after-life for a young man deliberately to be told by the university authorities that he can flagrantly neglect his duties sixty times in one term before any attention will be paid to it; while, if in business, the same young man would be discharged for being absent two or three times without permission.



SECTIONS, STEEL PASSENGER CAR.

Of all the habits and principles which make for success in a young man, the most useful is the *determination to do and to do right all of those things which come his way each day, whether they are agreeable or disagreeable;* and the ability to

*Extracts from an address delivered by Mr. Frederick W. Taylor Pres. Amer Soc. Mech. Eng., at the dedication of the new Engineering Building of the University of Pennsylvania, October 19, 1906.

INTERIOR VIEW OF HARRIMAN LINES STEEL PASSENGER CAR.

do this is best acquired through long practice in doggedly doing, along with that which is agreeable, a lot of things which are tiresome and monotonous, and which one does not like.

As to the object of college life: some boys are sent to the university to learn how to mingle with men and to form friendships which shall prove useful and agreeable in after-life. Some go there to amuse themselves and some to get the standing given by a college degree.

Something can be said for each of these objects. Is not the true object of all education, however, that of training boys to be successful men? I mean, men successful in the broadest sense, not merely successful money getters. Successful, first, in developing their own characters and, second, in doing their full share of the world's work.

Young men should not come to college mainly to get book-learning or a wide knowledge of facts. The successful men of our acquaintance are, generally speaking, neither learned, nor men of great intellect. They are men, first of all, possessed with an earnest purpose. They have a certain all-round poise, or balance, called common sense. They have acquired, through long training, those habits, both mental and physical, which make them masters over themselves; and at all times they have the firm determination to pay the price for success in hard work and self-denial.

. . . .

Is not the greatest problem in university life, then, how to animate the students with an earnest logical purpose?

In facing this question, I would call attention to one class of young men who are almost universally imbued with such a purpose, namely, those who, through necessity or otherwise, have come into close contact and direct competition with men working for a living. These young men acquire a truly earnest purpose. They see the reality of life; they have a strong foretaste of the struggle ahead of them, and they come to the university with a determination to get something practical from the college training which they can use later in their competition with men.

They are in great demand after graduating, and, as a class, make themselves useful almost from the day that they start in to work.

. . . .

I look upon this actual work and competition with men working for a living as of such great value in developing earnestness of purpose that it would seem to me time well spent for each student, say, at the end of the Freshman year, to be handed over by the university for a period of six months to some commercial, engineering or manufacturing establishment—there to work as an employe at whatever job is given him, either manual or other work. He should have the same hours and be under the same discipline as all other employes, and should receive no favors. Moreover, he should be obliged to stay even a longer time than six months, unless he has, in the meantime, given satisfaction to his employers.

. . . .

My belief in the benefits to be derived from doing practical everyday work early in the college course is not the result of a theory. It is founded upon close observation and study of young men who have had this experience, and also upon a vivid remembrance of breakfasting each morning at 5: 30 and starting to sweep the floor of a pattern shop as an apprentice some thirty-two years ago, after having spent several years in preparing for Harvard College. The contrast between the two occupations was great, but I look back upon the first six months of my apprenticeship as a pattern-maker as on the whole the most valuable part of my education. Not that I gained much knowledge during that time, nor did I ever become a good pattern-maker; but the awakening as to the reality and seriousness of life was complete and, I believe, of great value.

Unfortunately, laboratory or even shop work in the university, useful as they are, do not serve at all the same purpose, since the young man is surrounded by other students and professors and lacks the actual competition of men working for a living. He does not learn at college that, on the whole, the ordinary mechanics and even poorly educated workmen are naturally about as smart as he is and that the best way to rise above them lies in getting his mind more thoroughly trained than theirs and in learning things they do not know. All of this should be taught him through six months' contact with workingmen.

Let me repeat, in conclusion, that our college graduates are the best picked body of men in the community. Yet I believe that it is possible to so train young men that they will be useful to their employers almost from the day that they leave college, so that they will be reasonably satisfied with their new work instead of discontented, and to place them, upon graduating, one of two years nearer success than they now are, and that this can be best accomplished by giving them an earnest purpose through six months' contact early in their college life with men working for a living by rigidly prescribing a course of studies, carefully and logically selected, and with some definite object in view, and by subjecting them to a discipline comparable with that adopted by the rest of the world.

TOOL ROOM CARE AND ECONOMY.

MR. F. G. DE SAUSSURE.*

Although there is more or less truth in the old saying that "Any man can do good work with good tools, but it takes a good man to do good work with poor tools," still it is self-evident that the philosopher was not a product of the twentieth century shop, for, had he known the modern rush or worked under a "piece-work system," he would have seen that good tools are as essential to an organization as is good material, and that the tool room is the very heart of the modern shop body.

Much attention has been given to material, but the care of tools is woefully lacking in most of our large plants and systems, and yet a saving of expenses in this department is easily accomplished.

For the tool room foreman to care for the tools, it is necessary for him to know at all times the location of any particular tool, whether in service, under repairs or on the rack, and to gain this information a checking system must be installed—one that will cover at least four points: (1) Tools in service; (2) tools under repair; (3) tools ordered; (4) tools to be ordered. But, to have a checking system, it stands to reason that each tool belonging to the shop must have a separate and distinct place in the tool room and that its name, size or number be clearly stenciled under its place in the rack. There are numerous forms of racks, upon which the smaller tools, such as drills, taps, etc., may be kept, some conical in form, flat shelves or pigeon holes; but, for economy of space and simplicity, the slanting rack, as shown in Fig. 1, is probably the best. These racks are cheap in construction, durable and clean; no cupboards as dirt collectors, and can be placed wherever most convenient.

Upon the facing strips of these racks the name and size of the tool should be clearly stenciled (yellow cromine letters upon a black background making a good combination), and to do this, strips of bright tin cut 2 ins. wide are lampblacked, and the letters then stencilled upon them. The reason for using tin instead of painting upon the board itself is two-fold: a better surface and easier for the painter.

An easy method of laying out these tins is as follows: Take a roll of ordinary wrapping paper and saw 2 ins. off the end, thus giving a slip of paper 2 ins. wide and several hundred feet in length. Stretch these slips across the facing pieces of the rack and mark in lead pencil the size of the tool and space required. It is now easy for the painter to duplicate this upon the tin strips, and allows him to paint with them upon a table, insuring a quicker and better job than if he had to do the work with the tins previously nailed upon the racks.

After all tools are thus taken care of, the rules to keep them in their proper places cannot be too strict. It certainly would be of no advantage to provide a place for each tool and then to allow them to be thrown upon the floor or put up in the wrong rack.

The shop management has a choice in the checking system of whether the men shall carry their own checks or have them taken care of in the tool room. Experience compels the writer to say that, where the checks are carried by the men many complications will arise, checks left at home, lost, borrowed, stolen, and the interchange of check for tool other than at the tool room window. The first cost of taking care of the checks in the tool room is probably a little greater than when every man is given his bunch of checks, but its simplicity and accuracy soon pays for the cost of construction of a check rack.

APPEARANCE OF TOOL RACK.

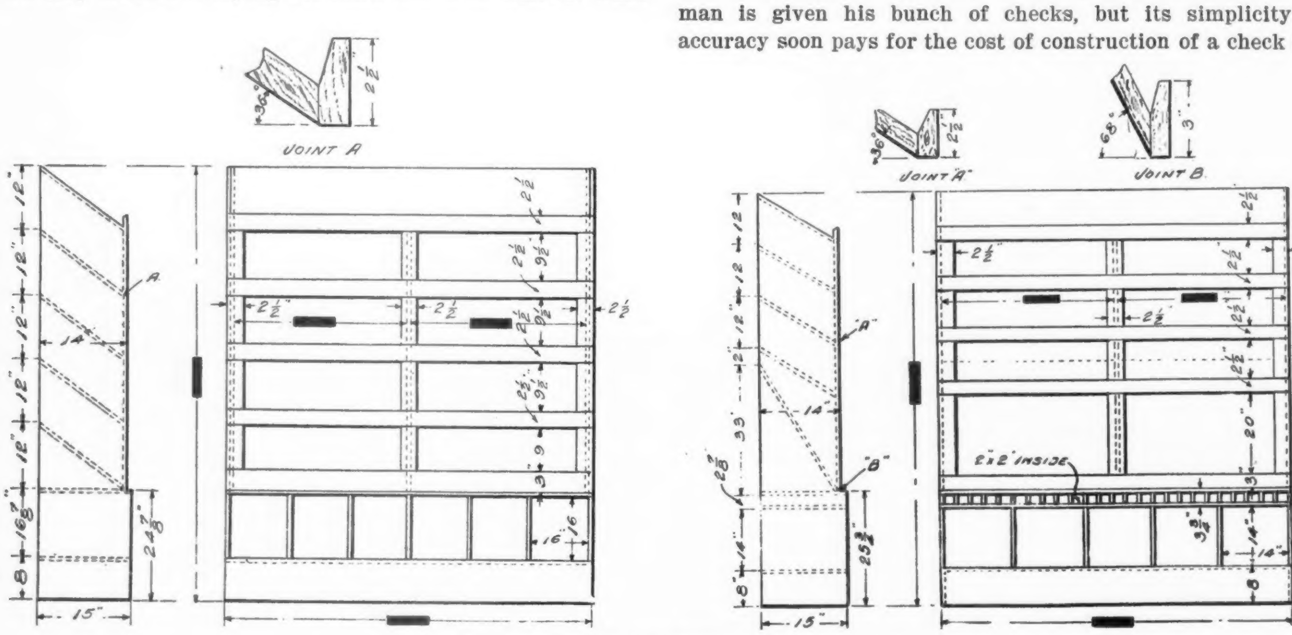


FIG. 1.—DETAILS OF TWO ARRANGEMENTS OF TOOL RACK.

A careful study of the check rack illustrated in Fig. 2 will show that the name of every employe is placed opposite a small pigeonhole containing twelve tin checks, say ⅝ x 1¼ ins. Each check (Fig. 3) has a small hole punched in one end, so that it may be hung upon a brad driven opposite the stenciled size of each tool. The employe's name is typewritten upon heavy paper, and this paper then cut into strips ¾ x 2 ins. and

*Erie Railroad Company.

the pieces placed between the edges of the folded tin receivers that are fastened to the name panel.

The continual shift of men in larger plants makes it necessary to keep changing the names from time to time, and, that the tool room foreman may keep posted and have his rack up-to-date, it would be well to adapt a form something similar to the following for the men employed:

> TO THE TOOL ROOM FOREMAN.—The bearer Mr............................has this day been employed by the Co., please give him a tool check number.
>
> ....
>
> Gen'l Foreman.
>
> ....
> ....
>
> (Typewrite here name of man employed.)

and for men leaving the service:

> TO THE TOOL ROOM FOREMAN.—The bearer Mr............................is this day leaving the Co.'s employ, kindly O. K. his checks and return.
>
> ....
>
> Gen'l Foreman.
>
> ....
>
> Tool Room Foreman.

The object of repeating the name of the man employed is that in the tool room this bottom name may be cut out and placed in the rack.

The racks themselves may be square, hexagonal or octagonal, according to the number of men employed, should be made of light material and have one side, or face, hinged to act as a door. To remove or replace a name, open the door, turn the thumb catches down, remove panel to inside of rack and take out or slip in name between edges of folded tin.

Let us now illustrate the system by following a tool. The employe, John Smith No. 98, comes to the delivery window and wishes the ¾ in. standard taps. The tool boy takes check No. 98 from the pigeonhole as he passes toward the tap rack, hangs it on the brad opposite ¾ in. "Standard Taps" and

FIG 3.

delivers the tools to Smith at the window. When the tools are returned, the check is again placed in the pigeonhole opposite Smith's name, or No. 98, and the tools placed on the rack in their allotted space.

To cover the four points enumerated above as being essential to a good checking system, the foreman should have on hand, say, fifty checks of the ordinary size painted blue, fifty painted red, and fifty painted yellow. A small blue print (Fig. 6), framed and hung in the tool room, will explain the use of these colored checks. Thus: John Smith brings back the ¾ in. standard taps, and one of them is broken. It cannot be used again, and so its place is vacant. If it can be repaired, hang a yellow check in the place of Smith's, again placing his in the pigeonhole, and place the tool under repairs as soon as practicable. If it cannot be repaired, place a red check and replace the broken taps with a new set from stock, thus keeping the rack full, and check out when called for, just as if the red check was not there. When ordered on either special or regular requisition, place the blue check on the brad. The difference between the "To be Replaced" and the "On Requisition" is readily seen to prevent the same tool being ordered on two requisitions. This method of checking enables the foreman to tell at a glance just where all tools are and what should be ordered to replace those broken or lost.

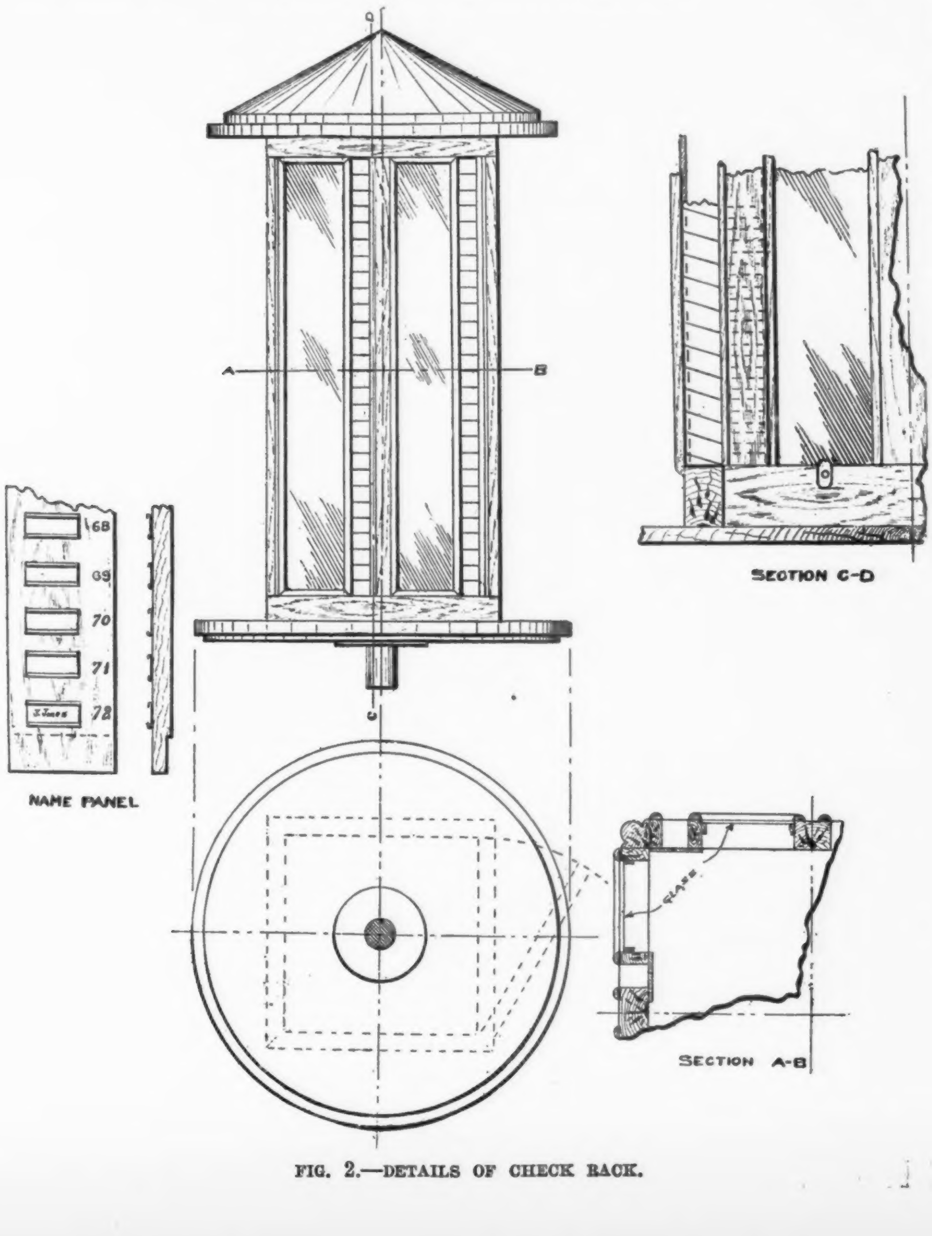
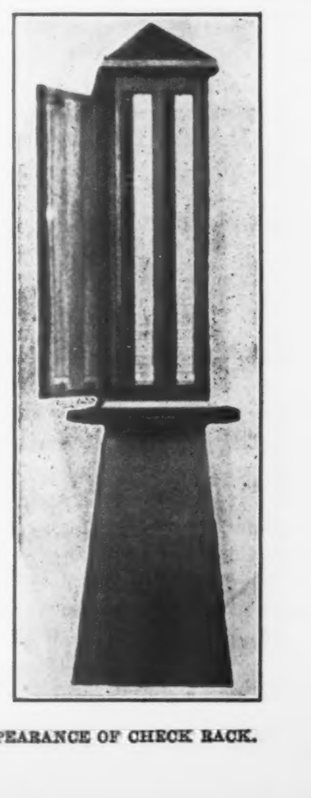


FIG. 2.—DETAILS OF CHECK RACK.



APPEARANCE OF CHECK RACK.

The tool room foreman should number all air hammers, air motors, jacks and tools of that kind, and a board (Fig. 4) should be placed near the delivery window, and the hammers, motors, etc., checked out in the usual manner, only the checks being hung upon the board, since the hammers are kept in an oil bath and the motors on a rack made of iron pipe, where it would be difficult to have brads opposite the tools.

It often is the case, especially in the larger plants, that more than one tool room is required. Take, for instance, a manufacturing concern in which the boiler shop is located some distance from the machine department. It would be an utter waste of time for a boiler-maker to be compelled to go to the machine department tool room for every tool that he might require, and it would surely be economy to have a small tool room in the boiler shop and equip it with such tools as are most used in boiler making. But it would be impracticable to give both shops an elaborate equipment, and for this reason some means of interchange between the two places must be established which will avoid the error of having an undue number of toolmakers, and yet provide ample facilities for the proper care of all tools and not complicate matters so that it is hard for the workman to secure whatever tool he may desire.

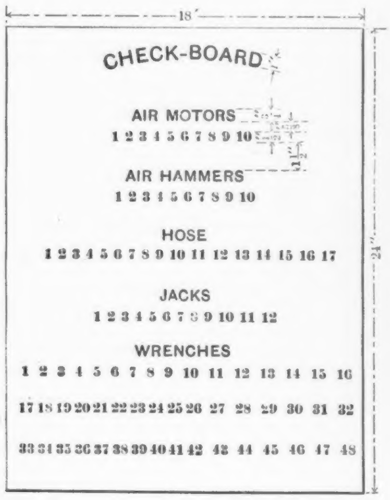


FIG. 4.

To reduce the number of toolmakers, establish one place as the main tool room and have all tools in need of repairs or to be made brought to the foreman of that place, and give that foreman charge over both tool rooms, so that there may be a clearly defined head and someone to whom all business pertaining to that department may be referred. To prevent the carrying of the boiler-makers' names in the machine department tool room and the consequently large rack, an exchange check should be used. Thus, a boiler-maker desiring a tool not kept in his department goes to the delivery window, and his check is taken from the pigeonhole and placed on a board in the place of a similar check marked "Boiler Shop Exchange," or simply "B. S. Exc," and with this exchange check he is entitled to any tool from the main tool room. When he has finished using the tool, he takes it back to the main tool room, receives the exchange check back, which, when taken to the boiler shop delivery window, will be again changed for his check, which is now replaced in the pigeonhole. This has the double advantage of keeping the men under their own department and at the same time protects the main tool room.

NAME OF SYSTEM.
Report of Broken Tools.

Date...

Tool Broken..

Broken By..

Remarks..

APPROVED.

....	....	....
T. R F'man.	Gen'l F'man.	Mast. Mech.

FIG. 7.

There cannot be too much said about broken tools, but it will suffice to say that, although many tools are broken through no fault of the operator, still it is safe to say that there are quite a number damaged through carelessness, and it is another case of the innocent suffering with the guilty. There should be a record kept of broken tools, similar to that shown in Fig. 7, and this record should be forwarded to the shop foreman and a careful investigation made, for it is only through some such system that the condition of the machine, as well as the carelessness of the employe, may be checked.

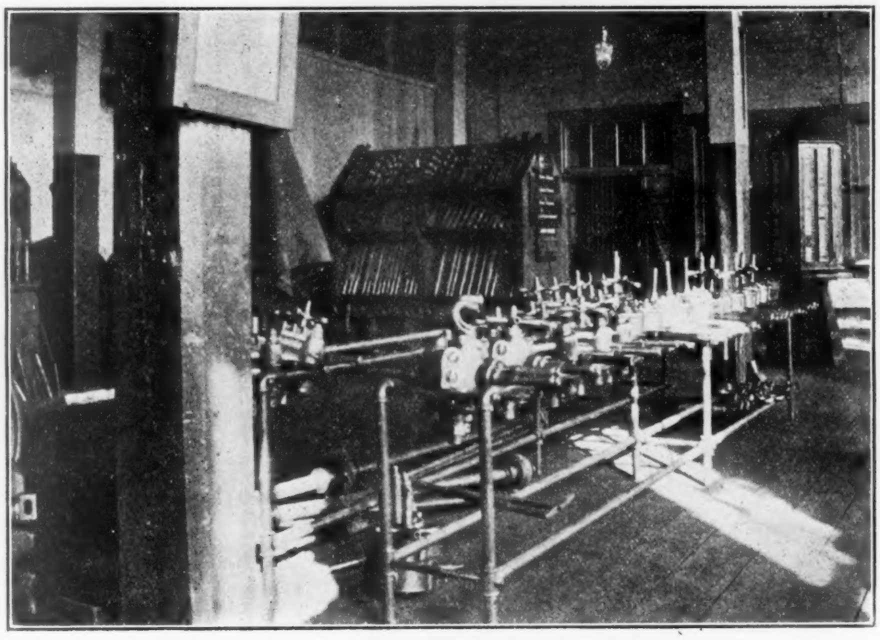


FIG. 5—RACK FOR AIR MOTORS.

On some of the larger railroad systems there are many special tools made at the different shops and used locally, but these tools are a long time finding their way into more distant shops, and for the purpose of having them in general service a "Book of Special Devices" should be made up at the head office. Each master mechanic should be furnished with one of these books, and, as a special tool is made, a drawing of it should be made and blue prints from this drawing sent to the master mechanics for their book, and tool room foremen should be at once authorized to construct these tools and place them in service.

KEY TO COLORS

WHITE	IN SERVICE
BLUE	ON REQUISITION
RED	TO BE REPLACED
YELLOW	UNDER REPAIRS

FIG 6.

But above all (and, I might say, the writer's hobby) is the question of a standard, and the reader will pardon a rather bold statement when I say that there should be no special tools, or, more correctly, no odd thread taps—no taps ranging in sixty-fourths or even thirty-seconds. If it is found that a certain class of engine needs a certain tap for its grease cup or crank-pin nut, then make that into a special device and have it a standard for the entire system. If a hole needs to be tapped in thirty-seconds, a shim of tin placed by the tap will answer all purposes. This thing of every shop having its own ideas as to what thread a certain nut should have, and no

other shop having the same thread tap, is entirely wrong and very expensive. All taps of a size should have the same size heads (as large as the stock will permit). All reamers of the same class should have the same taper per inch, the double and single end wrenches should fit the squares; "Morse tapers" should not be ground by hand on an emery wheel, and many other things too numerous to mention, but which, if permitted, will make a waste that would bankrupt the best of firms.

The questions of light, heat and size of shop make it impossible for the writer to give any definite statements or drawings as regards to the tool room layout, and so that part of the matter will be left to be governed by local conditions. One thing, however, should always be remembered, and that is that cleanliness is of the greatest importance, and, with this end in view, do not make your tool room into a storehouse nor yet into a junk pile.

HIGH STEAM PRESSURE IN LOCOMOTIVE SERVICE.*

BY DR. W. F. M. GOSS.

The Carnegie Institution of Washington, D. C., some three years since, became a patron of Purdue University for the purpose of promoting a research to determine the value of high steam pressures in locomotive service. The work outlined under these auspices has now been completed, and final report has been rendered the Institution. This report will soon be published. Meantime, the Institution has given its consent to the publication of a preliminary statement concerning methods and results.

1. *The Tests.*—The tests outlined included a series of runs, for which the average pressure was respectively 240, 220, 200, 180, 160, 120 lbs., a range which extends far below and well above pressures now common in locomotive service. The tests of each series were to be sufficiently numerous to define completely the performance of the engine when operated at any speed and for all positions of the reverse lever possible with a wide-open throttle. So far as practicable, each test was to be of sufficient duration to permit the efficiency of engines and boiler to be accurately determined, but where this could not be done, cards were to be taken.

The first test was run February 15, 1904, and the last August 7, 1905. A registering counter attached to the locomotive shows that between these dates the locomotive drivers made 3,113,333 revolutions, which is equivalent to 14,072 miles. The completed record includes the data of 100 different tests.

2. *The Locomotive* upon which the tests were made is that regularly employed in the laboratory of Purdue University, where it is known as "Schenectady No. 2." The characteristics of this locomotive are rather generally known.

3. *Difficulties in Operating Under High Pressures.*—The work with the experimental locomotive has shown that those difficulties which, in locomotive operation, are usually ascribed to bad water, increase rapidly as the pressure is increased. The water supply of the Purdue laboratory contains a considerable amount of magnesia and carbonate of lime. When used in boilers carrying low pressure there is no great difficulty in washing out practically all sediment. The boiler of the first experimental locomotive, Schenectady No. 1, which carried but 140 lbs. and was run at a pressure of 130 lbs., after serving in the work of the laboratory for a period of six years, left the testing plant with a boiler which was practically clean. Throughout its period of service this boiler rarely required the attention of a boilermaker to keep it tight. Water from the same source was ordinarily used in the boiler of Schenectady No. 2, which carried a pressure of 200 lbs. or more. It was early found that this boiler, which is of the same general dimensions as that of Schenectady No. 1, operating under the higher pressure, frequently required the attention of a boilermaker. After having been operated no more than 30,000 miles, cracks developed in the side sheets, making it impossible to keep the boiler tight, and new side sheets were applied. In operating under pressures as high as 240 lbs., the temperature of the water delivered by the injector was so high that scale was deposited in the check valve, in the delivery pipe and in the delivery tube of the injector. Under this pressure, with the water normal to the laboratory, the injectors often failed after they had been in action for a period of two hours. The loss of tests through failure of the injector, and through the starting of leaks at staybolts, as the tests proceeded, became so annoying that, as a last resort, a new source of water supply was found in the return tank of the University heating plant. This gave practically distilled water, and its use greatly assisted in running the tests at 240 lbs. pressure.

Probably some of the difficulties experienced in operating under very high steam pressures were due to the experimental character of the plant, and would not appear after practice had by gradual process of approach become committed to their use, but the results are clear in their indication that the problem of boiler maintenance, especially in bad water districts, will become more complicated as pressures are further increased. Since, taking the country over, there are few localities where locomotives can be furnished with pure water, the conclusion stated should be accepted as rather far-reaching in its effect.

The test developed no serious difficulties in the lubrication of valves and pistons under pressures as high as 240 lbs., though the lubrication could not be done with a grade of oil previously employed.

With increase of pressure, any incidental leakage, either of the boiler or from cylinders, becomes more serious in its effect upon performance. In advancing the work of the laboratory, every effort was made to prevent loss from such causes, and results were frequently thrown out and tests repeated because of the development of leaks of steam around piston and valve rods, or of water from the boiler. Notwithstanding the care taken, it was impossible under the higher pressures to prevent all leakage, and the best that can be said for the data under these conditions is that it represents results which are as free as practical from irregularities arising from the causes referred to; that is, so far as leakage may affect performance, the results of the laboratory tests may safely be accepted as the record of maximum performance.

In concluding this brief review of the difficulties encountered in the operation of locomotives under very high steam pressures, the reader is reminded that an increase of pressure is an embellishment to which each detail in the design of the whole machine must give a proper response. A locomotive which is to operate under such pressure will need to be more carefully designed and more perfectly maintained than a similar locomotive designed for lower pressure, and much of that which is crude and imperfect, but nevertheless serviceable in the operation of locomotives using a lower pressure, must give way to a more perfect practice in the presence of the higher pressure.

4. *The Effect of Different Pressures upon Boiler Performance* is summarized as follows:

1. The evaporate efficiency of a locomotive boiler is but slightly affected by changes in pressure, between the limits of 120 lbs. and 240 lbs.

2. Changes in steam pressure between the limits of 120 lbs. and 240 lbs. will produce an effect upon the efficiency of the boiler which will be less than ½ lb. of water per pound of coal.

3. The equation $E = 11.305 - .221\,H$, in which E is the number of pounds evaporated from and at 212 deg. per pound of coal, and H is the pounds of water evaporated per foot of heating surface per hour, represents the evaporative efficiency of the boiler of locomotive Schenectady No. 2 when fired with Youghiogheny coal for all pressures between the limits of 120 lbs. and 240 lbs. with an average error for any pressure which does not exceed 2.1 per cent.

4. It is safe to conclude that changes of no more than 40 or 50 lbs. in pressure will produce no measurable effect upon the evaporative efficiency of the modern locomotive boiler.

*A brief extract of a report submitted to the Carnegie Institution of Washington, August 17, 1906. Read at the November meeting of the Western Railway Club.

5. The effect of different pressures upon smokebox temperatures was found to be as follows:

1. The smokebox temperature falls between the limits of 590 deg. F. and 850 deg. F., the lower limit agreeing with a rate of evaporation of 4 lbs. per foot of heating surface per hour, and the higher with a rate of evaporation of 14 lbs. per foot of heating surface per hour.

2. The smokebox temperature is so slightly affected by changes in steam pressure as to make negligible the influence of such changes in pressure for all ordinary ranges.

3. The equation $T = 488.5 + 25.66\ H$, where T is the temperature of the smokebox and H is the weight of water evaporated from and at 212 deg. per foot of heating surface per hour, possesses a high degree of accuracy for all ordinary pressures.

6. *The Engine Performance.*—The shaded zone upon Fig. 1 represents the range of performance as it appears from all tests run under the several pressures employed. It shows that the variation in performance for all conditions of running which are possible with a wide-open throttle scarcely exceeds 5 lbs. For purposes of comparison, it is desirable to define the effect of pressure on performance by a line, and to this end an attempt has been made to reduce the zone of performance to a representative line. In preparing to draw such a line, the average performance of all tests at each of the different pressures was obtained and plotted, the results being shown by the circles on Fig. 1. Points thus obtained can be regarded as fairly representing the performance of the engine under the several pressures only so far as the tests run for each different pressure may be assumed to fairly represent the range of speed and cutoff under which the engine would ordinarily operate. The best results for each different pressure as obtained by averaging the best results for each speed at this pressure is given upon the diagram in the form of a light cross. These points may be regarded as furnishing a satisfactory basis of comparison in so far as it may be assumed

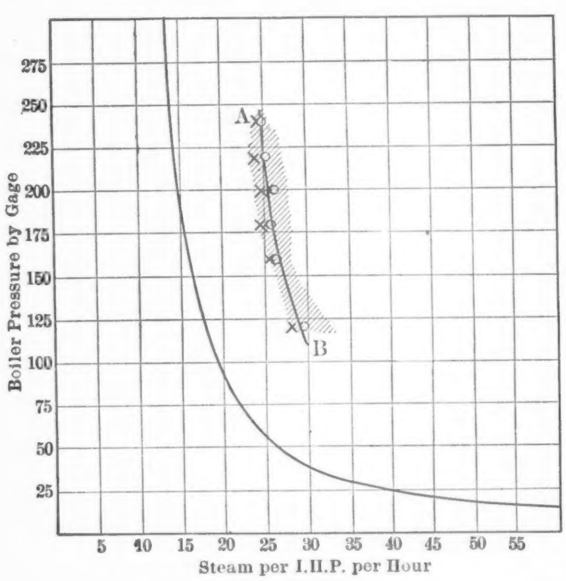


FIG. 1.

that when the speed has been determined an engine in service will always operate under conditions of highest efficiency. Again, the left-hand edge of the shaded zone represents a comparison based on maximum performance at whatever speed or cutoff.

In addition to the points already described, there is located upon the diagram Fig. 1 a curve showing the performance of a perfect engine, with which the plotted points derived from the data of tests may be compared.* Guided by this curve representing the performance of a perfect engine, a line A B has been drawn proportional thereto and so placed as to fairly represent the circular points derived from the experiments. It is proposed to accept this line as representing the steam consumption of the experimental engine under the several pressures employed. It is to be noted that it is not the minimum performance nor the maximum, but it is a close approach to that performance which is suggested by an average of all results derived from all tests which were run. Since its form is based upon a curve of perfect performance, it has a logical basis and, since it does no violence to the experimental data, it seems to be justifiable.

7. *Coal Consumption.*—Accepting the curve A B, Fig. 1, as fairly representing the consumption of steam, the corresponding consumption of Youghiogheny lump coal for the several pressures employed is shown by the following table:

	Coal		
		Saved for each increment of pressure	
	Per I. H. P., per hour.	Pounds.	Per cent.
240 lbs. boiler pressure........	3.31	....	...
220 lbs. boiler pressure........	3.35	0.04	1.2
200 lbs. boiler pressure........	3.40	.05	1.5
180 lbs. boiler pressure........	3.46	.06	1.7
160 lbs boiler pressure........	3.53	.07	2.0
140 lbs. boiler pressure........	3.67	.14	3.8
120 lbs. boiler pressure........	3.84	.17	4.4

The last two columns of the preceding table show the diminishing value of the fuel saving which results from a given increment of pressure as the scale of pressure is ascended. For example, increasing the pressure from 120 to 140 lbs. results in a full saving of 4.4 per cent., while a similar increment from 220 to 240 lbs. results in a saving of but 1.2 per cent.

8. *Increased Boiler Capacity as an Alternative for Higher Pressures.*—Previous publications from the Purdue laboratory have shown the possibility, under certain conditions, of securing a substitute for very high boiler pressures in the adoption of a boiler of larger capacity, the pressure remaining unchanged. If, for example, in designing a new locomotive, it is found possible to allow an increase of weight in the boiler as compared with that of some older type, it becomes a question as to whether this possible increase of weight should be utilized by providing a higher pressure or for an increase in the extent of heating surface. The results of tests supplemented by facts concerning the weight of boilers designed for different pressures and for different capacities supply the data necessary for an analysis of this question.

The full report presents with great elaborateness the facts which underlie the analysis. The results derived are well shown in Fig. 2, in which the full line curves represent the gain through the increase of boiler pressure and the dotted line the corresponding gain through the increase of boiler capacity. It will be seen that, starting with pressures which are compartively low, the most pronounced benefits are those to be derived from increments of pressure. With each rise in pressure, however, the chance for gain through further increase diminishes. With a starting point as high as 180 lbs., the saving through increased pressure is but slightly greater than that which may result through increased boiler capacity. For still higher pressures, the argument is strongly in favor of increased capacity.

The fact should be emphasized that the conclusions above described are based upon data which lead back to the question of coal consumption. The gains which are referred to are measured in terms of coal which may be saved in the development of a given amount of power. It will be remembered that conditions which permit a saving in coal will, by the sacrifice of such a saving, open the way for the development of greater power, but the question as defined is one concerning economy in the use of fuel. It is this question only with which the diagrams, Fig. 2, deal.

There are other measures which may be applied to the performance of a locomotive, which, if employed in the present case, would show some difference in real values of the two curves, A and B (Fig. 2). The indefinite character of these measures prevent them being directly applied as corrections to the results already deduced, but their effect may be pointed

*This curve represents the performance of an engine working on Carnot's cycle, the initial temperature being that of steam at the several pressures stated, and the final temperature being that of steam at 1.8 lbs. above atmospheric pressure. This latter value is the assumed pressure of exhaust in locomotive service.

out. Thus the extent to which an increase of pressure will improve performance has been defined, but the definition assumes freedom from leakage. If, therefore, leakage is allowed to exist, the result defined is not secured. Moreover, an increase of pressure increases the chance of loss through leakage, so that to secure the advantage which has been defined there must be some increase in the amount of attention bestowed, and this in whatever form it may appear means expense, the effect of which is to reduce the net gain which it is possible to derive through increase of pressure. Again, in parts of the country where the water supply is bad, any increase of pressure will involve increased expense in the more careful and more extensive treatment of feed-water, or in the increased cost of boiler repairs, or in losses arising from failure of injector, or from all of these sources combined. The effect of such expense is to reduce the net gain which it is possible to derive through increase of pressure. In view of these statements, attention should be called to the fact that the gains which have been defined as resulting from increase of pressure (Fig. 2) are to be regarded as the maximum gross; as maximum because they are based upon results derived from a locomotive which was at all times maintained in the highest possible condition, and as gross because on the road conditions are likely to be introduced which will necessitate deductions therefrom.

On the other hand, the relation which has been established, showing the gain to be derived through increased boiler capacity, is subject to but few qualifying conditions. It rests upon the fact that, for the development of a given power, a large boiler will work at a lower rate of evaporation per unit area of heating surface than a smaller one. The saving which results from diminishing the rate of evaporation is sure, whether the boiler is clean or foul, tight or leaky, or whether the feed-water is good or bad, the reduced rate of evaporation will bring its sure return in the form of increased efficiency. An increase in the size of a boiler will involve some increase in the cost of maintenance, but such increase is slight and of a sort which has not been regarded in the discussion involving boilers designed for higher pressure. Remembering, then, that as applied to conditions of service the line A is likely to be less stable in its position than B, the facts set forth in Fig. 2 may be briefly reviewed.

Basing comparisons upon an initial pressure of 120 lbs. (Fig. 2), a 5 per cent. increase in weight when utilized in securing a stronger boiler will improve the efficiency 8.5 per cent., while, if utilized in securing a larger boiler, the improvement will be a trifle less than 3 per cent. Arguing from this base, the advantage to be derived from an increase of pressure is great. If, however, the increase in weight exceeds 10 per cent, the curve A ceases to diverge from B, and if both curves are sufficiently extended, they will meet, all of which is proof of the fact that the rate of gain is greatest for relatively small increments of weight.

Basing comparisons upon an initial pressure of 140 lbs. (Fig. 2), the relative advantage of increasing the pressure, diminished though on the basis of a 5 per cent. increase in weight, is still double that to be obtained by increasing the capacity.

Basing comparisons upon an initial pressure of 160 lbs. (Fig. 2), the advantage to be gained by increasing the pressure over that which may be had by increasing the capacity is very slight, so slight, in fact, that a little droop in the curve of increased pressure (A) will cause the difference to disappear. As the curve B may be regarded as fixed, while A, through imperfect maintenance of boiler or engine, may fall, the argument is not strong in favor of increasing pressure beyond the limit of 160 lbs.

Basing comparisons upon an initial pressure of 180 lbs. (Fig. 2), the advantage under ideal conditions of increasing the pressure as compared with that resulting from increasing the capacity, has a maximum value of approximately one-half of one per cent. In view of the incidental losses upon the road, the practical value of the apparent advantage is nil. In view of what has been said with reference to the stability of the curves A and B, Fig. 2, constitutes no argument in favor of increasing pressure beyond the limit of 180 lbs.

Basing comparisons upon an initial pressure of 200 lbs. (Fig. 2), it appears that, under ideal conditions, either the pressure or the capacity may be increased with equal advantage, which, in effect, is a strong argument in favor of increased capacity rather than of higher pressure.

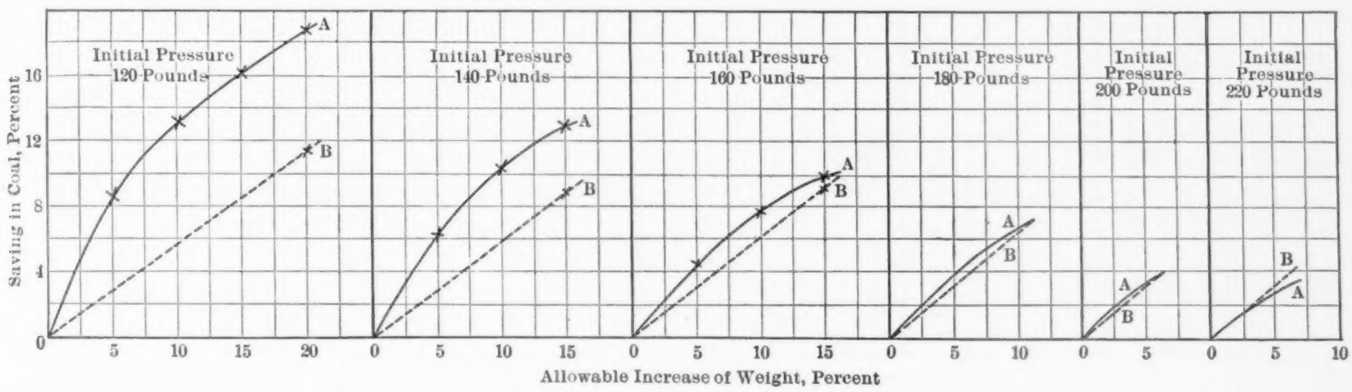


FIG. 2.

Basing comparisons upon a pressure of 220 lbs. (Fig. 2), it appears that even under ideal conditions of maintenance the gain in efficiency resulting from an increase of pressure is less than that resulting from an increase of capacity. In view of this fact, no possible excuse can be found for increasing pressure above the limit of 220 lbs.

8. *Conclusions.*—A summary of the whole work may be stated as follows:

1. Tests have been made to determine the performance of a typical locomotive when operating under a variety of conditions with reference to speed, power and steam pressure. The results of 100 such tests have been made of record.

2. The results apply only to practice involving single expansion locomotives using saturated steam. They cover only such conditions as may be maintained with wide-open throttle. Pressures specified are to be accepted as running pressures. They are not necessarily those at which safety valves open.

3. The steam consumption under normal conditions of running has been established as follows:

	Steam per H.P. hr.		Steam per H.P. hr.
120 lbs. boiler pressure..	29.1	200 lbs. boiler pressure..	25.5
140 lbs. boiler pressure..	27.7	220 lbs. boiler pressure..	25.1
160 lbs. boiler pressure..	26.6	240 lbs. boiler pressure..	24.7
180 lbs. boiler pressure..	26.0		

4. The results show that the higher the pressure, the smaller the possible gain resulting from a given increment of pressure. An increase of pressure from 160 to 200 lbs. results in a saving of 1.1 lbs. of steam per horsepower hour, while a similar change from 200 lbs. to 240 lbs. improves the performance only to the extent of .8 of a lb. per horsepower hour.

5. The coal consumption under normal conditions of running has been established as follows:

	Coal per H.P. hr.		Coal per H.P. hr.
120 lbs. boiler pressure..	3.84	200 lbs. boiler pressure..	3.40
140 lbs. boiler pressure..	3.67	220 lbs. boiler pressure..	3.35
160 lbs. boiler pressure..	3.53	240 lbs. boiler pressure..	3.31
180 lbs. boiler pressure..	3.46		

6. An increase of pressure from 160 to 200 lbs. results in a saving of 0.13 lbs. of coal per horsepower hour, while a similar change from 200 to 240 results in a saving of but 0.09 lbs.

7. Under service conditions, the improvement in performance with increase of pressure will depend upon the degree of perfection attending the maintenance of the locomotive. The values quoted in the preceding paragraphs assume a high order of maintenance. If this is lacking, it may easily happen that the saving which is anticipated through the adoption of higher pressures will entirely disappear.

8. The difficulties to be met in the maintenance both of boiler and cylinders increase with increase of pressure.

9. The results supply an accurate measure by which to determine the advantage of increasing the capacity of a boiler. For the development of a given power, any increase in boiler capacity brings its return in improved performance without adding to the cost of maintenance, or opening any new avenues for incidental losses. As a means of improvement, it is more certain than that which is offered by increase of pressure.

10. As the scale of pressure is ascended, an opportunity to further increase the weight of a locomotive should, in many cases, find expression in the design of a boiler of increased capacity rather than in one for higher pressures.

11. Assuming 180 lbs. pressure to have been accepted as standard, and assuming the maintenance to be of the highest order, it will be found good practice to utilize any allowable increase in weight by providing a larger boiler rather than by providing a stronger boiler to permit higher pressures.

12. Whenever the maintenance is not of the highest order, the standard running pressures should be below 180 lbs.

13. Wherever the water which must be used in boilers contains foaming or scale-making admixtures, best results are likely to be secured by fixing the pressure below the limit of 180 lbs.

14. A simple locomotive, using saturated steam, will render good and efficient service when the running pressure is as low as 160 lbs.; under most favorable conditions, no argument is to be found in the economical performance of a machine which can justify the use of pressures greater than 200 lbs.

Cost of Incandescent Lamps.—In the beginning of the career of the incandescent electric lamp about 75 cents worth of platinum was used in a single lamp, and the bulb was blown by hand from a piece of tubing. At the present time the platinum in a lamp costs about ½ cent and the bulb, which is made in large quantities at the glass factories, costs about 2 cents. It may appear from this that the present selling price of such lamps —18 cents for the ordinary size—is unnecessarily high; but when it is considered that there are some fifty operations in the process of manufacture, nearly all of which require special skill, and many of which involve refinements of manipulation which are nothing less than marvelous, this thought changes to one of wonder that the price can be made so low.—*The Illuminating Engineer.*

Officials Burdened With Minor Matters.—Officials in general are burdened with a senseless diversity of minor subjects under advisement. Long hours and hard work scarcely suffice to keep up with the mass of routine details. Careful thinking along broad general policies must be left to absorb time needed for rest and recreation away from the office. The secret of the success of the largest dry goods and manufacturing house in the country is the instant weeding out of every man as soon as he has reached the limit of his ability, whether it be as errand boy or partner. It follows that every boy who enters their employ understands that no dead timber is retained to block his opportunities for certain promotion as rapidly and as far as he can win it.—*Paul R. Brooks, before the New York Railroad Club.*

REPAIRS TO STEEL FREIGHT CARS.*

By J. F. MacEnulty.

As you are doubtless aware, the first steel freight cars in any large quantity were built in 1897, by the Schoen Pressed Steel Company. Previous to that time there were iron box cars on the New York Central in 1871; the Harvey Steel Car Company had built cars to order as early as 1891, and prior to 1888 some tubular frame cars were constructed by the Southern Iron Car Company. Prior to 1897, however, the steel car had many enemies and few good friends, due, doubtless, to a natural conservatism on the part of the railway men and to the obviously experimental stage of steel car development.

Some early designs of steel cars were gotten up in competition with wooden car weights which then existed, and the argument that a great ratio of paying load to dead weight was to be had sold a great many cars. As a consequence, many cars were designed that were really too light for the exceptionally heavy service. At this stage of development, however, the weight of the car up to a certain point is not considered; for instance, 50-ton cars for general service weighed, in 1902, 35,000 lbs.; to-day the same capacity cars weigh 45,000 lbs., or an increase in dead weight of 10,000 lbs. in four years. The questions now are: Will it stand the severe buffing shocks? Will it keep off the repair track? Railroads now realize that a car continually in service more than pays for the hauling of its dead weight by an increased number of loads. For roads where service is not so heavy a car with a greater ratio of paying load to dead weight can be used to advantage.

The first steel cars were built almost entirely of pressed shapes; then other manufacturers designed cars to be built entirely of structural shapes. To-day the builders of so-called "structural cars" use pressed shapes and structural shapes, and pressed shapes are used where in the mind of the designer they are most feasible. The days of light construction are over; we are increasing the weight of rails, of engines, etc. Where ten years ago an 80,000 lbs. capacity car was considered unusual, the 100,000 lbs. capacity car is now common, and the railroads look for a greater capacity. The time will come when many of us will see trains of cars, each unit carrying 150,000 lbs. or over. In fact, to-day this matter is being seriously considered by at least one leading road. True, there are many such cars now, but they are made for special use, and cannot be classed as a general service type.

From the records of nine representative car-building concerns in the year 1905 there were 224,817 cars ordered; of these 148,493 were steel and 76,324 of wood. With steel cars coming so rapidly to the front, the question of repairs is a very live issue. In repairing steel cars a road which has none in service usually resorts to the use of skilled labor or will return the cars to the builder; either method is costly, and is very apt to prejudice the management's decision when the question of steel versus wood construction is brought up. There is absolutely no need of any railroad, large or small, employing skilled labor or returning the cars to the manufacturer. Skilled labor is not used at shops where cars are built; then why use skilled labor to repair them? When a car is new, naturally the question of appearance and finish is one of the important points of inspection. When a car is out of service the question of utility is uppermost, and any repairs should be made in the cheapest manner consistent with good service. Why pay boilermakers' prices to have a perfectly finished rivet driven, when a laborer at half the pay will drive one in half the time that will perform its office satisfactorily? A little experience with the rough-and-ready car repairer versus slow skilled labor is usually convincing. Railways are now using the same repair gangs for both wood and steel cars, and the results are shown in the reports of car repairs published from time to time in the railway journals. If the car foreman lacks the ingenuity or confidence to make

*From a paper presented before the October meeting of the New England Railroad Club.

the necessary repairs, send him to Altoona, Mt. Clare or Collinwood, where they are past masters in the art. Unless his natural prejudice has overcome his mental balance, the expense of his trip will be repaid many times.

In the early days of repairs to steel cars it was the custom when a sill was bent to dismember the car and take the piece out to straighten it. Now, an oil furnace or a charcoal fire is put under the car, and when the sill is heated sufficiently it is put back into shape by a pulling jack applied to suit conditions. When sills are broken a splice can be made by making a butt joint with plates on inside and outside, all securely riveted.

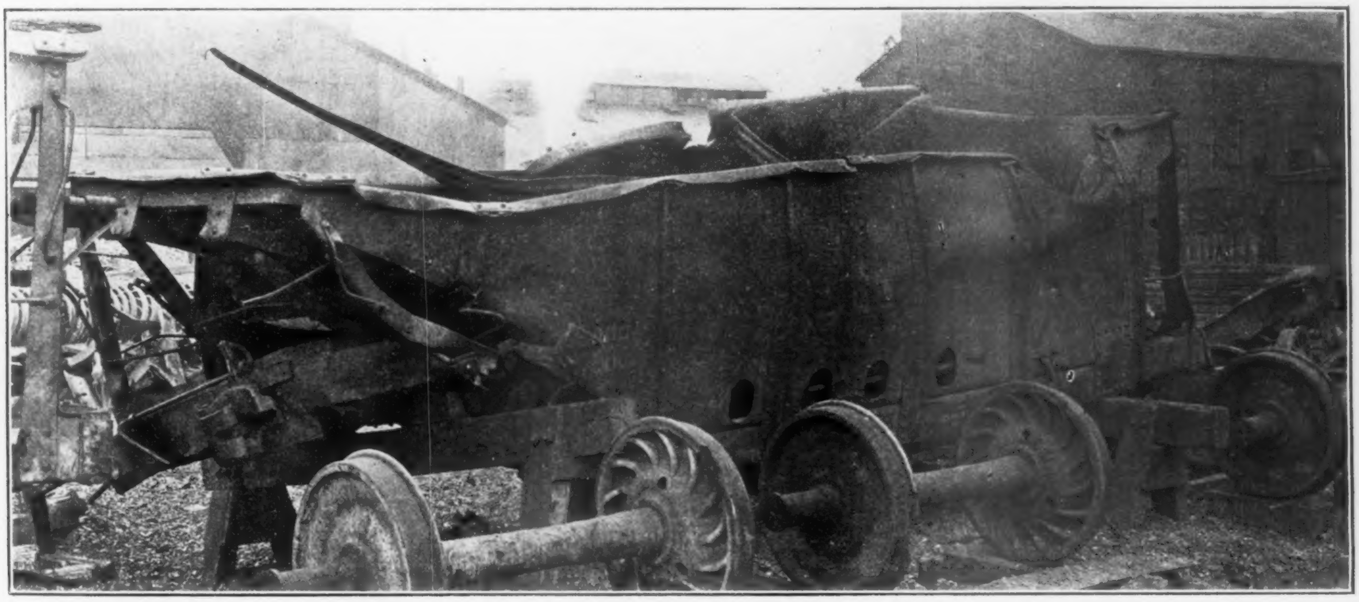
Steel cars received on repair tracks on account of wrecks very seldom have any of the frame or body lost, so it is simply a matter of cutting off the bent small parts, straightening them and riveting in place.

It is, however, advisable when purchasing new cars to order a small supply of the steel shapes that will most likely be needed for running repairs. This saves time and inconvenience, for no matter what arguments may be put forth about buying shapes, etc., in the open market, when the time comes for such purchase it will be found hard to get immediate delivery, and harder still to shape material for application to cars. On the average road there is not enough demand for repair parts to warrant the expense of putting up a special shop; this condition makes it necessary to look to the car builder for material, whether it be of structural or pressed shapes.

Pressed and structural members, or such as end and corner posts, stakes, flange angles and plates, can be cut off by hand and heated in a gas or oil fire, and straightened on a large flat surface plate or anvil with ordinary smith's tools. One gang of men at this forge can take care of this class of work for a large number of cars. Heating and bending will not injure the steel entering into the construction of cars, so that practically all the parts removed from a steel car can be utilized either in their original shape or as a patch on some other part.

It must be taken into consideration that shocks and treatment that would ordinarily destroy a wooden car merely make the steel car an object that draws the anathemas of the wrecking crew, and the solicitous consideration of the repair gang. Gone is the inevitable bonfire that was a simple method of clearing up the debris. The alternative now is either to bury the car or send it to the repair tracks; it won't burn. Heavier and more powerful cranes are necessary, but the right of way is more easily and quickly cleared. When a chain is put around a corner post or sill the whole car moves, not merely a section, as heretofore. The only record of steel cars wrecked, that could not be repaired, were a few near Pittsburgh that rolled over a 200-ft. embankment into a swollen river and were carried about two miles away from the railroad. It was impracticable to tow them back. Aside from a few similar instances, there is no record of a steel car being wrecked in such a manner that the cost of repair would render it advisable to scrap it.

The cost of steel car repairs is, on the whole, very small by comparison, when it is taken into consideration that comparative costs of repairs of the two types as given by railways are, as a rule, manifestly unfair. The maintenance reports given for publication are generally taken only for cars that have been repaired. When it is a wood car this means, on an average, slight repairs. But what of the wood cars destroyed? There are thousands of such every month. Should not the cost of renewals, less a scrap credit, be added to the wood car maintenance sheet to arrive at an equitable basis for comparison with the steel cars? This would throw a great balance on the steel car side of the controversy, and would bring forth the argument that many of the wood cars thus destroyed were old and of an obsolete type. While this is true, yet the old car has a money value; a car is a car on the records, and the failure of the old wood cars serves only to enhance the value of the up-to-date steel car that will not disintegrate.



EXAMPLE OF BADLY WRECKED STEEL FREIGHT CAR.

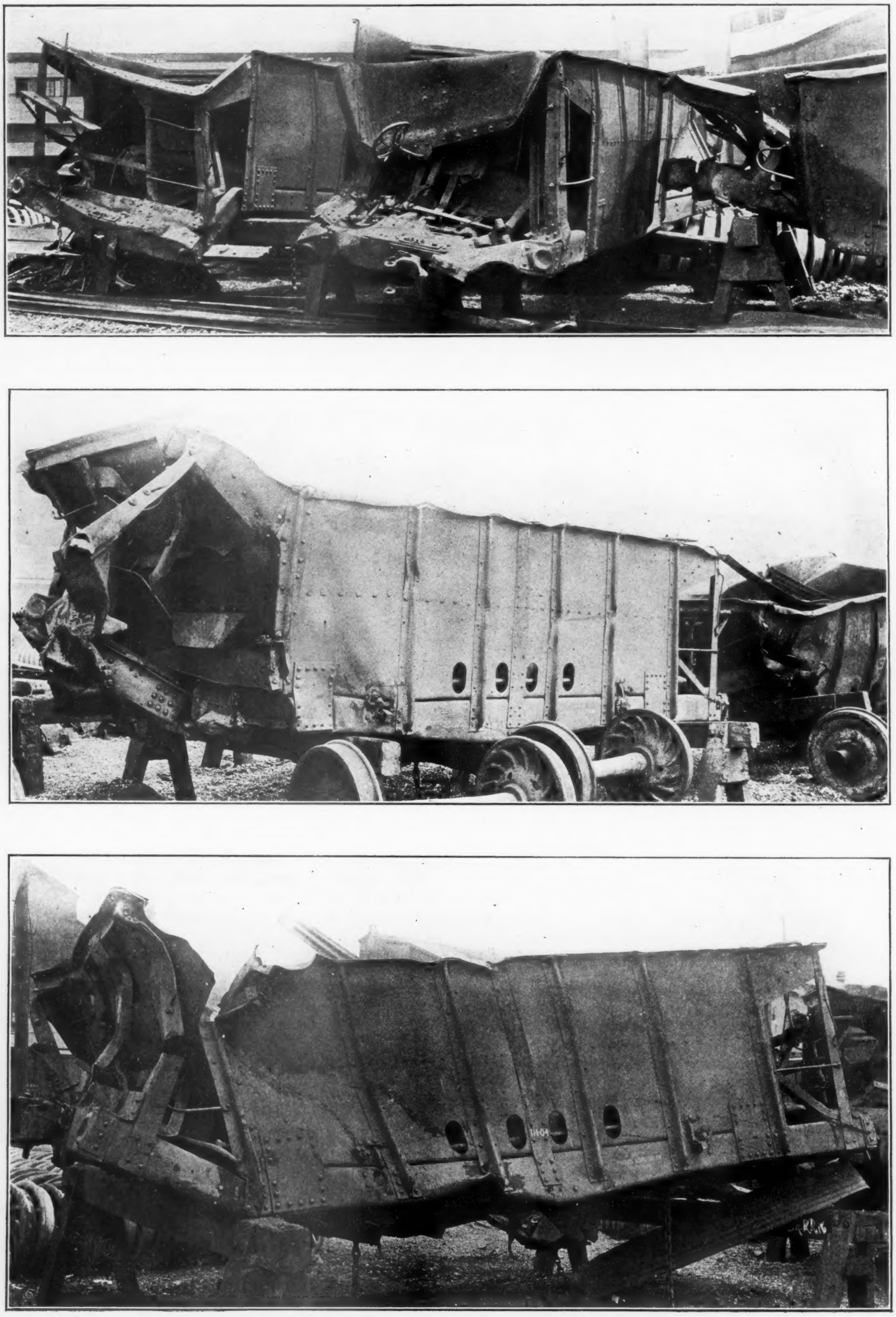
The average cost of repairing steel cars varies considerably with the type, and as a larger number of 100,000 lbs. capacity steel hoppers have been built than any other class, costs of their repair would be more interesting. Below is a record of average costs of certain kinds of repair to this type:

COST OF REPAIRING 100,000 LBS. CAPACITY STEEL HOPPERS.

One end having side and end sills, draft sills and corner braces and brackets badly bent	$36.50
Both ends damaged as above and body badly sprung	85.75
To cut entire frame and body apart and re-rivet	140.00
The above is the labor charge of cutting off the bent parts, straightening and re-riveting in place, the only new material used being rivets.	
A steel car having been in a wreck that would totally destroy the body and frame of a wooden car can be repaired as good as new for	$50.00
A steel hopper so badly wrecked that scrapping it was considered was repaired good as new for	160.00

These figures are from systems using over 100,000 steel cars, some of them having been in service from seven to eight years. They estimate that the cost of car maintenance is reduced 35 per cent., and stock for repairs 50 per cent., by use of all-steel construction, taking an equal number of cars of both types as a basis.

As regards care of cars, while some roads do not consider it necessary to repaint their steel freight equipment, yet the old saw, "An ounce of prevention is worth a pound of cure,"



EXAMPLES OF BADLY WRECKED STEEL FREIGHT CARS.

might be applicable. Any metal surface exposed to the elements is none the worse for a little attention, and on any other structure it would be considered a necessity. At a prominent repair point, where 500 cars per month are repainted, the average cost for gondola or hopper cars is as follows:

Sand blasting	$0.45
Paint for body and lettering	6.00
Labor for body and lettering (according to locality)	$1.00 to 2.00

The above costs for repair and painting do not include the trucks. The accompanying photographs illustrate what a steel car will stand. These cars, each containing fifty tons of ore, ran three miles down a 4 per cent. grade, and with the engine jumped over the end of a switchback, the cars and engine going by actual measurement 422 ft. before striking the ground; the point of contact was frozen ground, the drop being 53 ft. from track level. The engine and cars then rolled 516 ft. These seven cars originally cost about $1,200 each. The cost to repair was an average of $690 each, which was the manufacturer's cost, and included 10 per cent. profit and an operating and administration expense that on a railroad would be largely taken care of in other operations, and not charged entirely to cars, as is necessary for a car builder. A large part of the cost was in the trucks, owing to the peculiar nature of the wreck. Eliminating the trucks, the repairs to the bodies cost but $350 each. In repairs to trucks alone, it was necessary to replace 17,700 lbs. of steel, 56 journal boxes and lids, 54 brake shoes, 56 journal bearings and wedges, 28 groups of springs, 20 axles, 25 wheels, 1,200 lbs. of forgings and 3,900 lbs. of castings, or a total of 68,800 lbs. of material. A wood car under similar conditions would have been good only for firewood and a small scrap credit for truss rods, grab irons, etc. This wreck for a small number of cars represents about as severe a condition as could be met, and goes to prove the argument that a steel car is always good enough to be repaired.

LOCOMOTIVE BOILERS WITH COMBUSTION CHAMBERS.

Referring to the second paragraph of the editorial in your October issue on the Northern Pacific engines with the combustion chamber which states, "The combustion chamber was used in the original Wootten fireboxes and remained a part of that design until it was found to be of no particular advantage, and engines without it steamed as well and were less expensive to maintain."

These are not the facts in the case entirely. The majority of the anthracite roads, while they had a few engines equipped with the combustion chamber, had comparatively few. The Reading Railroad, however, had a very large number of engines with the combustion chamber. For some cause or other, which I do not know at the present time, it was decided about five years or more ago that whenever one of these engines received a new firebox, the combustion chamber was to be omitted, and a straight flue sheet put in instead, the reason doubtless being the trouble they were having with combustion chambers. We now have running on the road, due to this policy, engines with and without combustion chamber of absolutely the same design and dimensions throughout. There is no question whatever that engines with combustion chambers, although having a less amount of total heating surface, are better steamers, give much less trouble with flues, and are cheaper to maintain as regards boiler repairs. Moreover, it is very frequently necessary, due to a shortage for some local cause, of fine anthracite coal, to occasionally burn straight soft coal in these Wootten boxes with combustion chambers, and. while the grate surface is too large for the straight soft coal, and more steam is generated than can be used, still under these conditions, there is no question again but that the combustion chamber engine has very decided advantages over the straight flue sheet, and our experience in this matter would certainly indicate the use of a combustion chamber in a soft coal engine as a desirability.

The principal trouble with the combustion chamber engines has been largely due in the past to two causes; first, the very narrow water space surrounding combustion chamber, which, in many cases, on the older engines, is not over three inches, and secondly, the fact that the majority of water stations on the Reading Road have a water supply which contains a very high percentage of mud, and which mud was almost always found deposited first under the combustion chamber, filling the opening up entirely, and burning out, cracking and breaking the sheets. On the older engines, this trouble has practically been done away with by the application of a very large and easy opening blow-off cock directly underneath combustion chamber, and the putting in force of rules requiring two or three gauges of water to be blown out of engine through this blow-off cock daily, thus removing the mud from under the combustion chamber.

The advantages of the combustion chamber engine in steaming qualities, maintenance of fire box and flues over the straight flue sheet are so very decided that during the last two years all engines built have been equipped with this combustion chamber, and undoubtedly this policy will continue. Of course, in the newer design of engine, very much larger water space surrounding combustion chamber has been given, as well as the blow-off cock to remove the sediment which accumulates at that point.

From the above it will be noted that the combustion chamber is not abandoned, and that furthermore, the Northern Pacific are not the first to burn straight soft coal with combustion chamber, as this has been done many years ago, and very successfully, although, as before stated, such coal not being standard to the design of engines, furnished more steam than could be used.

Yours truly,

F. F. GAINES,

Reading, Pa. Mechanical Engineer.

ELECTRIC CAR TESTING PLANT.—The new electrical laboratory of the Worcester Polytechnic Institute, Worcester, Mass., now in process of construction, which will be one of the largest in the world, will have an interesting plant for the study of electric railroad traction. The equipment of this department will consist of a motor generator set, a four-motor electric car equipment, a complete set of multiple unit control apparatus and complete air-brake equipment. The motor generator set is composed of a 300-h.p. 2,200-volt 60-cycle synchronous motor, mounted on the same base with and directly connected to a 200-k.w. rotary converter, arranged to deliver either 600-volt direct current or 400-volt two-phase or single phase 25-cycle alternating current, as may be required. The car equipment consists of four motors of a combined capacity of 160 h.p., with controllers, trolleys, switches, resistances, cables, etc., all of the latest type of the General Electric Company, and will be used for the motive power of the institute's test car, which will be of the modern interurban type, as large as will safely pass over the New England electric lines. The car will be equipped with instruments and apparatus for making exhaustive tests of the lines over which it passes. The control apparatus will be mounted in working order in the laboratory and will be so arranged that it may be used as control for the test car. A Westinghouse electric pneumatic unit switch control system will also be installed, so that both systems may be studied and comparisons made under different operating systems. There will be a number of air-braking outfits of the several makes.—*Iron Age.*

FORMAL OPENING RAILROAD Y. M. C. A.—The Norfolk & Western Railway recently voted to expend $70,000 in buildings for Young Men's Christian Associations on their line, and in connection with the opening of one of these buildings—that at Portsmouth, Ohio—on Thursday, November 15, President L. E. Johnson, of the Company, made the following statement: "This association is an association not only of you men who realize its need, but the officials of the road are associated with it in building it and putting the money of the stockholders into it and for its support, all because we heartily believe in it, and we count it as one of the necessary items of expense in modern railroad equipment. There should exist among yourselves an effort to maintain the manhood of your association work. I congratulate you on the opening of this building, its secretaries, board of management and friends; and last, but not least, the men who shall be most directly benefited—the men of the Norfolk & Western Railway service, and wish you Godspeed in your undertaking in this association for the days to come."

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CONTENTS.

BETTERMENT WORK.

"Eliminating wastes" may be said to be the watchword of betterment work. Mr. Frederick W. Taylor, the recent president of the American Society of Mechanical Engineers, was one of the first to systematically and scientifically study this matter and to introduce methods to reduce the wastes to a minimum and bring the efficiency of an operation or of an entire plant to a high point.

Some few persons seem to have thoroughly grasped the spirit of Mr. Taylor's work and have applied it with splendid results. Needless to say, the carrying on of such work requires an exceptional man and one of very broad caliber. One superintendent of motive power imbued with this spirit accomplished splendid results, such wonderful results in fact, that his work attracted the attention of several prominent manufacturing concerns, and he found it much to his advantage to leave railroad service.

There can be no question but what on many railroads there are very great possibilities for increasing the efficiency of the motive power department and operating it more economically, but this can never be completely accomplished until those in charge wake up and place the motive power department on the high plane which its importance deserves. Then, instead of allowing manufacturing concerns to take our best men, conditions will be reversed and the railroads will see to it that the men who are fitted to accomplish such wonderful results will not be allowed to drift away into other work.

* * * * * * *

It must not be understood from the above that there are not many very high grade men in the motive power department and that they are not doing splendid work, but in many instances the results of their efforts would be multiplied many times over if they had the power and authority that they should have. While the motive power departments have been steadily widening out and increasing in importance, it was not until recently that special efforts were made along betterment lines, and indeed these efforts at the present time are confined to a few of the roads and, generally speaking, are directed along widely different lines. One road, for instance, realizes the importance of perfecting the organization of the motive power department. A careful study is made of the qualifications of the different men. Where advisable, salaries are increased to keep good men and to encourage them in their efforts. Measures are taken to get the leaders together and have them work as a team or unit. At the same time shop equipment and conditions are improved and an attempt is made to raise the standard of the workmen. All this, of course, has accomplished splendid results. On another road little has been done to improve the supervision, but a system of handling the men has been installed to, as far as possible, secure their co-operation in increasing the efficiency and capacity of the repair plants. On still another road a competent man, and one of long experience, has been appointed to follow up certain features of the work, to make a careful study of them and to at the same time increase the efficiency and reduce the expense for that particular work or department. On another system we find that a committee has been appointed whose duty it is to carefully investigate all the shops and repair plants on the system and to present recommendations for improving their efficiency.

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The road, however, that has taken the most radical measures is the Santa Fe. This work was described at length in our December issue, in fact we considered it of such importance that almost the entire paper was devoted to that one subject. The methods of Mr. Harrington Emerson, who has had charge of the betterment work on that road, differ quite materially in detail from those of Mr. Taylor, but are actuated by the same spirit or general principles. In a nutshell, the results accomplished on the Santa Fe are due to the increased supervision and to the fact that the co-operation of the men was secured in eliminating wastes and improving the efficiency.

* * * * * * *

One feature in connection with the betterment work on the Santa Fe should be clearly understood. While this work was started by a separate organization, known as the betterment department, yet it has been the policy, as far as possible, to work through the mechanical department organization and to make the duties of the betterment department largely advisory. For instance, for a considerable time the betterment work at the Topeka shops has been handled entirely by the shop organization. After the betterment department had gotten the work well started it was placed in the hands of Mr. John Purcell, the shop superintendent, and with the advice of the betterment department he completed its introduction. Gradually the entire work of the betterment department is thus being absorbed by the mechanical department organization.

The appointment of Mr. H. W. Jacobs to the position of assistant superintendent of motive power of the Santa Fe, as announced on another page of this issue, has a peculiar significance. Mr. Jacobs has been connected with the betterment work from its very start and has had charge of betterments to the shop equipments and tools for the entire system, and has had entire charge of the betterment work on the Coast Lines since it was first introduced there. As it is only a question of a short time when Mr. Emerson will find it necessary to give up his work on the Santa Fe, the betterment work will undoubtedly be entirely absorbed in the mechanical department organization and will be carried on under Mr. Jacobs as assistant superintendent of motive power.

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The bonus system introduced on the Santa Fe must not be confused with other bonus systems; for instance, under other systems no bonus is paid unless the standard time is reached. If the standard time for a piece of work is four hours and the man sees that it will take a little more than four hours to do the work, and that he will be unable to earn any bonus, there is no incentive for him to hurry the work through, as his rate of pay will be just the same if he takes five or six hours to do it. With Mr. Emerson's system the job would begin to pay a small bonus for time and a half, or six hours, and this would gradually be increased, as the time was reduced, until at four hours the bonus would be 20 per cent. If the job is done in less than four hours, under Mr. Emerson's system the worker gets the entire benefit of his efforts, while with other systems the profit due to the gain in the man's time is divided between the man and the company.

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An important feature in connection with the bonus system on the Santa Fe is the abolishing of overtime. In the repair shops the bonus schedules lapse when overtime is paid, thus tending to discourage the custom of working overtime. If a man works beyond a certain point his efficiency becomes impaired and the company is the loser.

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The question may arise as to the reduction in the force because of the increased output due to the introduction of the bonus system. In all large shops men are continually leaving the service and being replaced by new ones. When introducing the bonus system on the Santa Fe it was found unnecessary to make any special reduction in the force, but as men dropped out they were not replaced.

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The graphical records used in connection with the betterment work on the Santa Fe are an important feature. Such records can be maintained at a comparatively small cost. They enable the officers to quickly and accurately comprehend the condition of affairs, giving them an accurate and broad view of the situation and locating the weak points. Graphical records have been used very extensively upon the Chicago Great Western and the Northern Pacific Railways. The system in use in the mechanical department of the Northern Pacific Railway was described at length in an interesting article by Mr. L. A. Larsen in our December, 1905, issue, page 451. Mr. Emerson's idea of 12-month averages, which more clearly show the actual tendencies and eliminate differences due to seasons, etc., is, however, a new and valuable one.

During the past three years an interesting and valuable series of experiments has been under way at Purdue University for the purpose of accurately determining the relative economy of various steam pressures on locomotives. These have now been completed and a full report made to the Carnegie Institution of Washington, D. C., which instigated and paid the expenses of the experiments. An abstract of this report, giving its general features and results, was read by Dr. W. F. M. Goss at the November meeting of the Western Railway Club, and is given in full in this issue. It forms a valuable addition to the literature on steam locomotives, and positively settles some points about which there has been considerable conjecture. It shows, for instance, that while there is an increased economy with increased pressures up to 240 pounds per square inch, the amount of saving per increment of pressure very rapidly decreases as the pressure is increased above 180 pounds. This point is so decided as to lead to the conclusion that as far as economy is concerned it is not advisable to use pressures greater than 180 pounds on single expansion locomotives, and as high as that only when the boiler can be well maintained. The slight saving possible from higher pressures will no doubt be more than counteracted in practical service, by the loss from the many insignificant leaks generally accompanying it. Also, aside from the loss by direct leakage, the loss in evaporative efficiency of the boiler and the trouble with check valves and injectors by the much more rapid deposit of hard scale is also to be considered as an offset to the slightly increased economy.

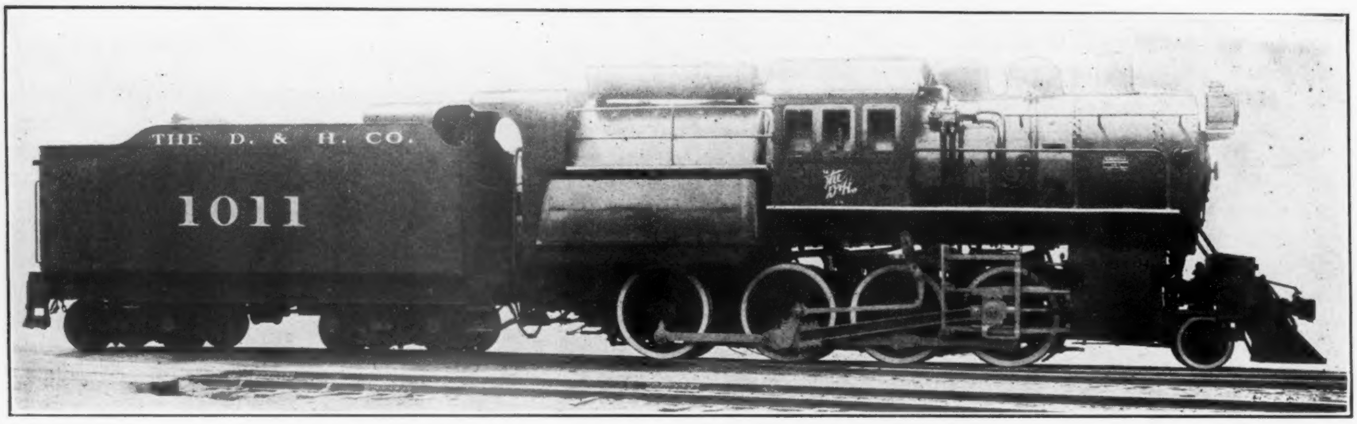
Dr. Goss made it clear, both in this paper and in his topical discussion at the last Master Mechanics' convention, that this question is being considered from the standpoint of design, and that the results do not necessarily indicate that it is advisable to reduce the pressures in boilers now carrying 200 pounds or more, even if the cylinders are enlarged to give equal power. The idea is consistently carried throughout the report that the comparisons are between boilers of equal weight and not equal size or heating surface.

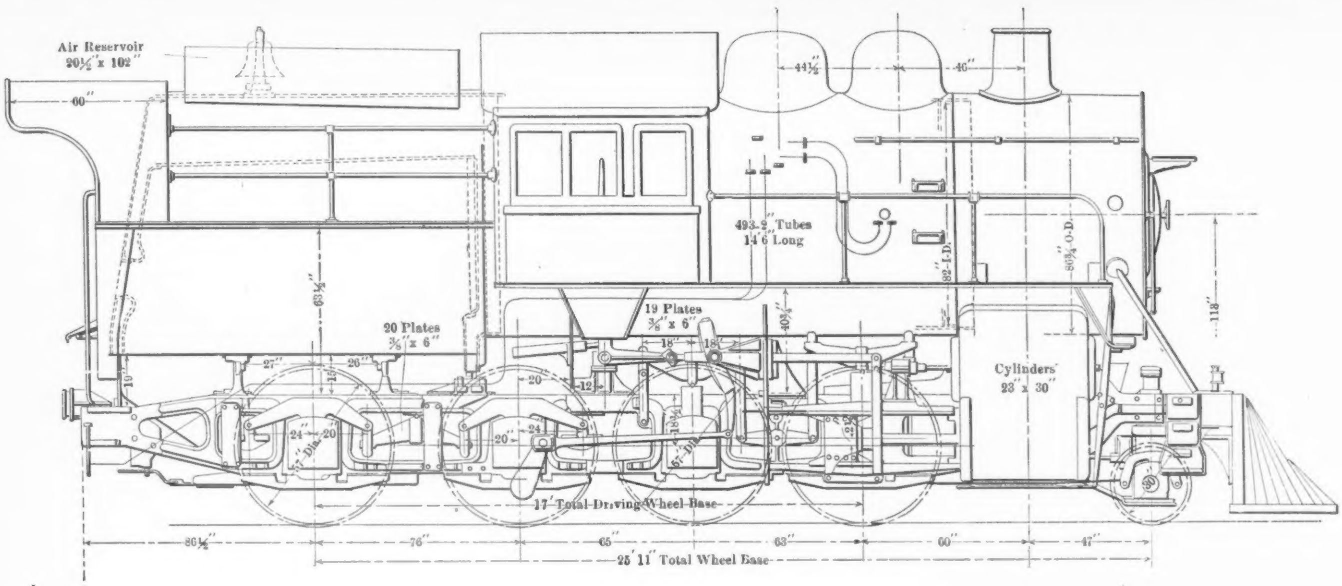
In an address delivered at the recent dedication of the new Engineering Building of the University of Pennsylvania, Mr. Frederick W. Taylor discusses the causes and possible remedies for one defect which, he states, practically all young college graduates seem to have in common. That is, their dissatisfaction and comparative uselessness for a period of from six months to two years immediately following graduation. An exception, however, is made of those men who through necessity or otherwise have, either before or during their college course, come into close contact and direct competition with men working for a living. That this condition has attracted serious attention was illustrated by an example cited wherein a certain company in filling several attractive positions, specified that technical graduates should be given a preference, but that none should be employed who had not been graduated for at least two years.

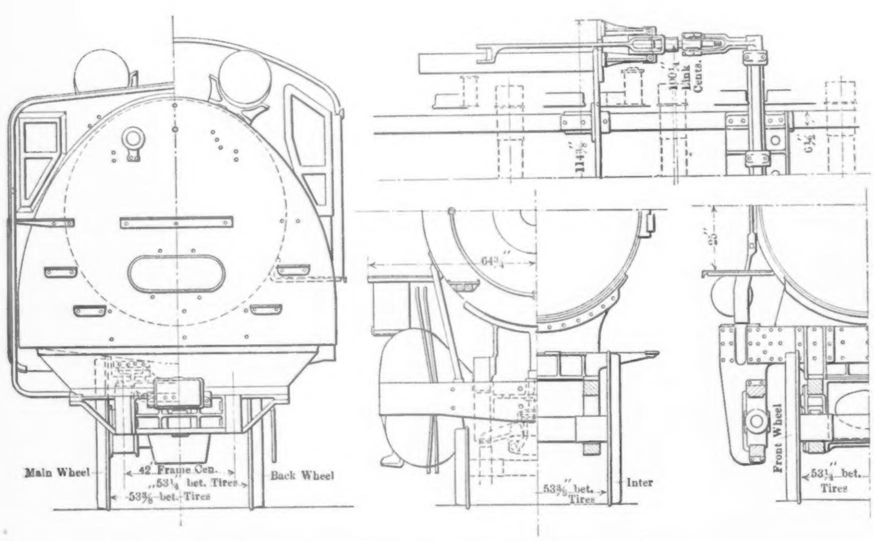
If such an idea becomes general, there is a hard time ahead for the young technical graduate, but we do not believe that the facts of the case warrant any such general application, and that an examination of the records of the men graduated from our technical schools in 1904 will show that any large proportion of them have been even comparatively useless to their employers. There are, no doubt, individual cases, and in certain particular localities possibly a fair proportion of the men where this condition will be found to be true, but it is a matter for individual consideration, and the whole class should not be condemned by the failure of one or two. This is a matter of men not of car wheels or air hose.

The address points out the fact that the sheltered existence, and comparatively lax discipline of the colleges and universities are such as to make the following contact with real life considerable of a shock and probable disappointment to the ordinary young graduate and makes several suggestions for improvement in this respect. Possibly the most important of these is the suggestion that the university make it obligatory for the student to spend six months or more, preferably at the end of the Freshman year, in some commercial, engineering or manufacturing establishment—there to work as an employe at whatever job is given him. The idea of this is to give the student close contact on an equal plane with practical workmen, so that he may be aided in developing an earnestness of purpose which will be of benefit not only after graduation, but in the remainder of his college course as well.

Some such scheme would, no doubt, be of much practical value to the student, provided it could be arranged so as not to curtail or further crowd the present usual course of instruction.







HEAVY CONSOLIDATION FREIGHT LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

DELAWARE & HUDSON COMPANY.

The American Locomotive Company has recently built, at its Schenectady works, six consolidation locomotives for the Delaware & Hudson Company, which are now in slow freight pushing service on the Homesdale branch, between Carbondale and Racket Brook, Pa. These locomotives weigh 246,500 lbs., of which 217,500 is on drivers, and are, with one exception, the largest and most powerful engines of this class of any on our record. The locomotive built in 1900 for the Pittsburgh, Bessemer & Lake Erie Railroad, which weighed 250,300 lbs. total, exceeds them slightly in weight and, by reason of its larger cylinders, higher steam pressure and smaller wheels, gives a much larger tractive effort. The accompanying table of four large consolidation locomotives will permit comparisons to be made between these engines and their nearest competitors. It will be seen that they have the same diameter of cylinders as are used on the heavy freight locomotives on the Lake Shore & Michigan Southern Railway, which were illustrated in our July issue, but, by reason of the smaller wheels and higher steam pressure, the tractive effort is considerably larger. The Lehigh Valley locomotive, also included in the table, was built in 1898 by the Baldwin Locomotive Works and has Vauclain compound cylinders. This was a single locomotive, built for pushing service, and at the time of its construction was next to the heaviest locomotive in the world.

The Delaware & Hudson engines were built for burning fine anthracite coal and have a grate area of practically 100 sq. ft. This is served by a single fire door 36 ins. wide and 12½ ins. high. The O'Connor patent fire door flange, which gives the inner firebox sheets a very large radius at the fire door opening, has been used. The barrel of the boiler is made up of two cylindrical sections, the forward and smaller one measuring 83¾ ins. outside diameter, and the other 85⅝ ins. The tubes, of which there are 493, are 2 ins. in diameter and 14 ft. 6 ins. long, giving a heating surface of 3,716 sq. ft., are set 2¾ ins. between centers.

The frames are cast steel of the I section design, which has been very successful on this road. The use of the Walschaert valve gear has permitted the frames to be well braced and stiffened at several points, particularly just ahead of the main drivers, where a very heavy combination cross tie and reverse shaft bearing has been placed. Unusually large and long pedestal binders, which are fastened by three bolts, passing through the frame on either end, have been used. The design of the Walschaert vaive gear used in this case is very similar to that employed on other freight locomotives recently built by this company. The support for the valve stem is carried on the upper guide bar and the connection to the combination lever is below the radius bar connection. The link is carried by a bracket extending back from the guide yoke. The location of the reverse lever has allowed the direct connecting of the reverse shaft arm to the radius bar of the valve gear through a slip joint. The general dimensions, weights and ratios are as follows:

Road	P.B. & L.E.	D. & H.	L.S. & M.S.	L. V.
Total weight, lbs.	250,300	246,500	232,500	228,082
Weight on drivers, lbs.	225,200	217,500	207,000	205,232
Tractive effort, lbs.	63,800	49,690	45,677	47,700
Size cylinders, ins.	24x32	23x30	28x32	18&30x30
Diam. of drivers, ins.	54	57	63	55½
Steam pressure, lbs.	220	210	200	200
Diam. of boiler, ins.	84	83¾	81⅝	80
Total heating surface, sq. ft.	3,805	4,045.5	3,705.23	4,145
Tube heating surface, sq. ft.	3,564	3,716	3,492.18	3,952
Grate area, sq. ft.	36.8	99.75	56.5	90
Fuel	Bit. coal	Anth. coal.	Bit. coal	Anth. coal
Total weight ÷ total heat. surface	65.8	60.8	62.8	55
Weight on driv. ÷ total heat. sur.	59	53.9	56	49.5
Trac. effort × diam. driv. ÷ t't'l H.S.	905	700	775	640
Weight on drivers ÷ total weight, %.	90	88.5	88.5	90
Total heat. sur. ÷ vol. cylinders	228	280	240	305
Reference in AMERICAN ENGINEER	1900 p. 214	This issue	1906 p. 262	1898 p. 395

SIMPLE CONSOLIDATION LOCOMOTIVE.

DELAWARE & HUDSON COMPANY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Freight
Fuel	Hard coal
Tractive effort	49,690 lbs.
Weight in working order	246,500 lbs.
Weight on drivers	217,500 lbs.
Weight on leading truck	29,000 lbs.
Weight of engine and tender in working order	398,900 lbs.
Wheel base, driving	17 ft.
Wheel base, total	25 ft. 11 ins.
Wheel base, engine and tender	57 ft. 7½ ins.

RATIOS.

Weight on drivers ÷ tractive effort	4.37
Total weight ÷ tractive effort	4.97
Tractive effort × diam. drivers ÷ heating surface	700
Total heating surface ÷ grate area	40.5
Firebox heating surface ÷ total heating surface, per cent	8.12
Weight on drivers ÷ total heating surface	53.9
Total weight ÷ total heating surface	60.8
Volume both cylinders	14.4 cu. ft.
Total heating surface ÷ vol. cylinders	280
Grate area ÷ vol. cylinders	6.92

CYLINDERS.

Kind	Simple
Diameter and stroke	23 x 30

VALVES.

Kind	Piston
Greatest travel	5½ ins.
Outside lap	1 in.
Inside clearance	0 in.
Lead in full gear	3/16 in.

WHEELS.

Driving, diameter over tires	57 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	10 x 12 ins.
Driving journals, others, diameter and length	10 x 12 ins.
Engine truck wheels, diameter	30 ins.
Engine truck, journals	6½ x 12 ins.

BOILER.

Style	Straight
Working pressure	210 lbs.
Outside diameter of first ring	83¾ ins.
Firebox, length and width	126¼ x 114 ins.
Firebox plates, thickness	3/8 and 9/16 ins.
Firebox, water space	4 ins.
Tubes, number and outside diameter	493, 2 ins.
Tubes, length	14 ft. 6 ins.
Heating surface, tubes	3,716 sq. ft.
Heating surface, firebox	329.5 sq. ft.
Heating surface, total	4,045.5 sq. ft.
Grate area	99.75 sq. ft.
Smokestack, diameter	20 ins.
Smokestack, height above rail	15 ft. 2 ins.
Center of boiler above rail	113 ins.

TENDER.

Tank	Water bottom
Frame	15 in. channel
Wheels, diameter	33 ins.
Journals, diameter and length	5½ x 10 ins.
Water capacity	7,800 gals.
Coal Capacity	14 tons

ELECTRICAL EQUIPMENT OF THE ERIE RAILROAD SHOPS AT HORNELL (HORNELLSVILLE), N. Y.

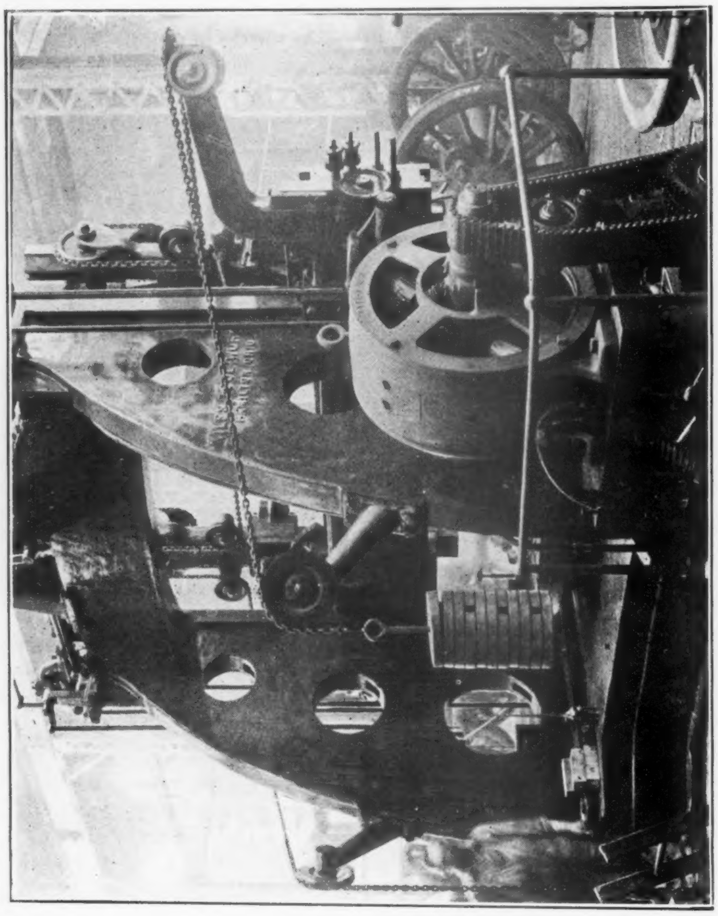
When the present management took charge of the Erie Railroad it adopted broad and comprehensive plans for the development of the entire property, which are rapidly making it one of the most modern and efficient railway systems in the country. These plans embraced extensive alterations and additions to the shops of the system in order to improve their efficiency and capacity.

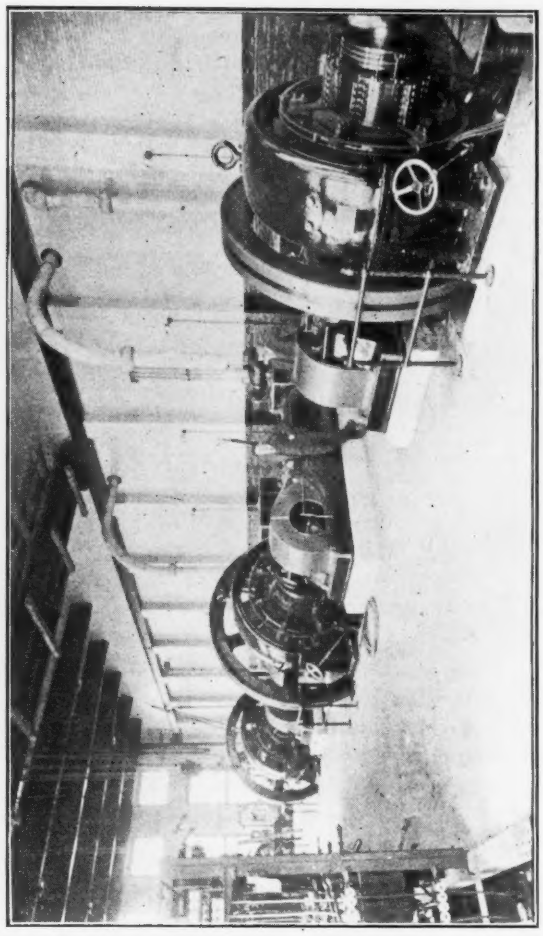
New shop buildings and round houses have been constructed, old machines replaced by new, an efficient shop organization effected, and the entire mechanical department brought up to a high standard of efficiency. This work, under the direction of Mr. E. A. Williams, general mechanical superintendent, and Mr. G. W. Wilden, mechanical superintendent, has been carried on at many different points on the system, but the most extensive single installation of modern shop equipment is at the Hornell shops, located at Hornell, N. Y. At this point new buildings have been erected, additions made to old buildings, a new power house erected, and a large number of new machine tools, with a complete system of electric drive, installed. This installation is an interesting and instructive illustration of the latest engineering practice for a railway shop where the largest proportion of power is required at short distances from the power house, and a large proportion of variable speed and crane load is required.

The operation of machine tools by electric motors is especially adapted to railroad shop work. The large work handled necessitates extensive buildings, and the use of great lengths of shafting and belting if power is transmitted mechanically from a central source. Rush repair jobs are frequent, and require a great deal of overtime and Sunday work, when power requirements are small, as but sufficient machinery is operated to complete the particular work at hand. Mechanical transmission of power under such conditions is wasteful in the extreme, owing to the surplus power required to overcome the friction of shafting and belting throughout the shops. Where the electric drive is used—either individual or group—a flexibility is obtained that cannot be secured by any other means, as it permits the use of a few machines independently, requiring a minimum amount of power.

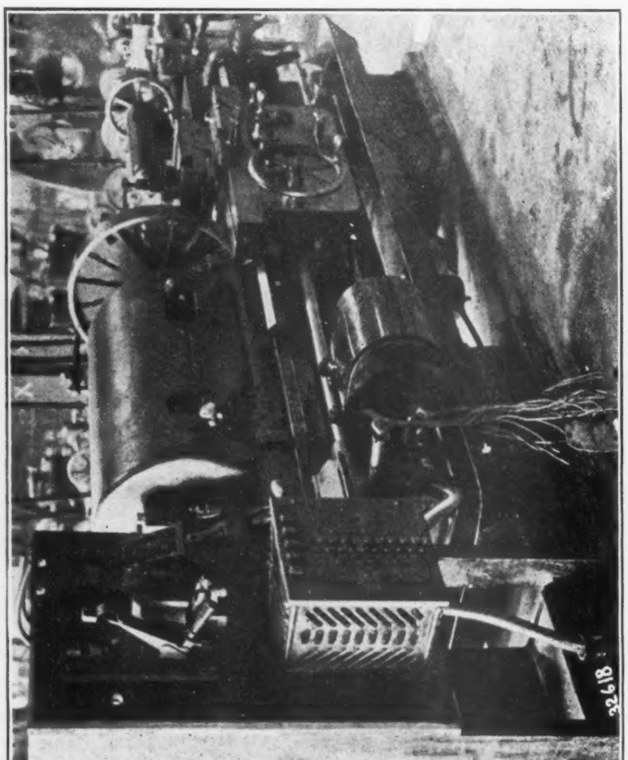
There are many other considerations in connection with power transmission, one of the most prominent being the layout of the plant, which is especially important in a railroad shop, as it is generally made up of a number of separate buildings aside from the main machine and erecting shop, which are necessarily scattered, widely distributing the power requirements, and necessitating the use of a number of prime movers. Where engines are used, steam is supplied either from a central boiler plant or by individual boilers forming a combination unit with the engine. The former arrangement is poor, from an economical standpoint, owing to the low efficiency resulting from the excessive condensation which takes place in long lengths of steam pipe. Either method involves the expense of skilled attendants, which amounts to a considerable sum annually. Electric motors, on the other hand, require a small amount of attention, provide power that is perfectly reliable, and reduce the time of starting and stopping and changing speed to a minimum. The electric motor for operating cranes, transfer and turntables is superior to other motive powers, due to its ease of control, efficiency and reliability.

Before making a final decision as to the type of electrical apparatus to be installed a careful comparison was made of the alternating current and direct current types of apparatus. This analysis included not only the motors themselves, but also the various accessories, such as wiring, controllers, etc. Due consideration was also given to an installation involving the use of both alternating and direct current motors, but

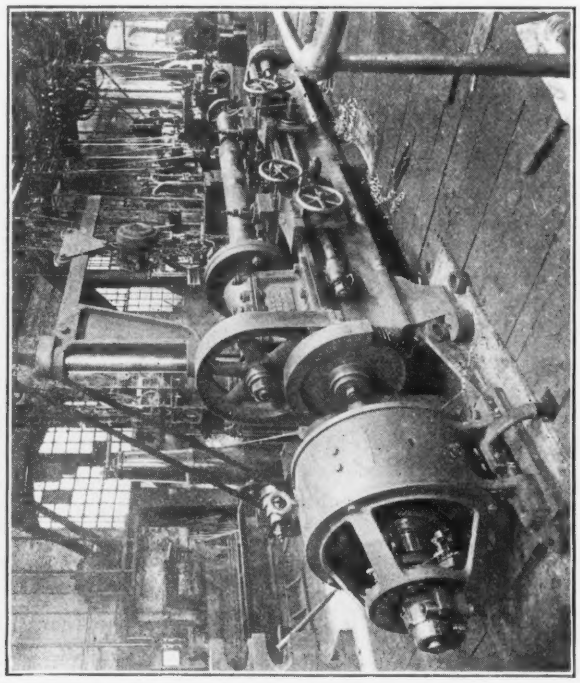




INTERIOR OF ENGINE ROOM, POWER HOUSE

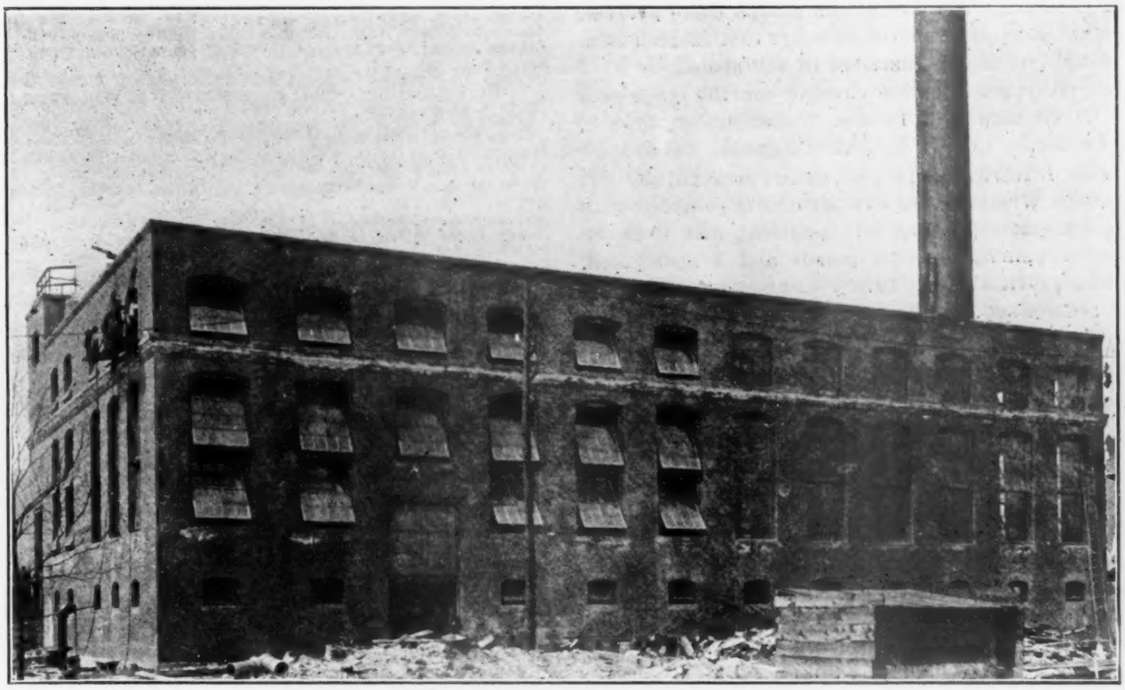


MOTOR-DRIVEN CRANK PIN LATHE.



NILES LATHE—MOTOR-DRIVEN.

while it appeared probable that at some time in the future an equipment of this nature would be necessary, it was decided that present conditions did not justify the installation of both types of motors. Under the conditions existing at Hornell it is apparent that all of the motors are located well within the limits of 220 volts distribution, and in additon that there is at this time no woodworking shop in existence; therefore it was resolved to make the installation consist entirely of direct current apparatus, with the exception of a small generator set, which is used to supply the current necessary for the present yard and depot lights. This installation is an



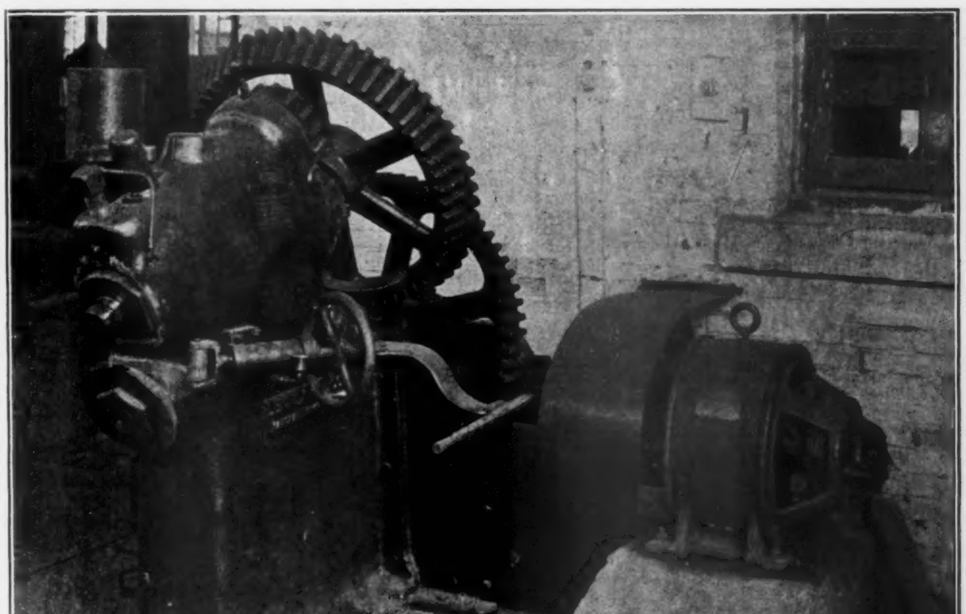
POWER HOUSE, HORNELL SHOPS—ERIE RAILROAD.

excellent illustration of the principle that each railroad shop must be considered as a separate and independent problem, and it is impossible to lay down any hard and fast rules which can be taken as a guide, but that each particular case must be thoroughly investigated, and a final decision reached in conformity with the conditions existing at that point.

Enlargement of the power house at some future time has been provided for. The type of apparatus to be placed in the engine room will be determined upon at the time of making the addition, as the present system can readily be expanded in either of two ways. Additional power can be obtained by the installation of the necessary capacity, either in an alternating current generator, which would supply the lines direct, the present motor generator set acting as a tie between the present units and the future one, or a direct current generator, with the necessary transforming apparatus for alternating current, can be installed if it is found advisable.

The power house is a large brick structure of fire-proof construction, with concrete roof and flooring. The building is large enough to provide for future extensions, foundations already being in place for doubling the boiler capacity, so that it is only necessary to erect the additional units. The boiler plant consists of four Babcock & Wilcox units of 400 h.p., operating at 150 pounds pressure, and equipped with chain grates. All live steam mains are provided with the Holley drip system. The coal handling and stoking is especially interesting, as, from the time the coal is dumped from the cars until it is fed into the furnace, it is conveyed automatically. The coal passes from the car into a chute, which empties into a crusher, and is then conveyed by an endless belt to the top of the power house, where it passes through another chute to the second conveyor that distributes it in the bunkers over the boiler room. From there the coal passes through chutes to hoppers in front of the furnaces, where it is fed onto the grates. The amount of coal admitted into the hoppers is controlled in the boiler room by means of levers. The conveyors, which were manufactured by the Exeter Machine Company, have a capacity of sixty tons per hour, and are operated by a 10-h.p. and a 13½-h.p. Westinghouse, type S, motor. The coal crusher is operated by a 20 h. p., type S. motor.

The generating equipment consists of three Ball & Wood cross-compound, high-speed condensing engines, two of 500-h.p., each direct connected to a Westinghouse 300 kw., direct current, 250-volt, 3-wire generator running at 150 r.p.m., and one of 400 h.p. direct connected to a similar generator of 200 kw. capacity, operating at 200 r.p.m. The engines run condensing except in cold weather, when the exhaust steam is utilized in heating the shops. Water for condensing purposes is stored in a large well, which derives its supply from a



LENOX BEVEL SHEAR, MOTOR-DRIVEN.

small river near the power house.

Besides the generating equipment and pumps there are two Ingersoll-Sergeant compound air compressors that furnish compressed air to the pneumatic hammers in the shops.

A motor-generator set supplies current for the yard and depot lights. It consists of a 115-h.p. Westinghouse, type S, motor direct connected to a 75 kw., Westinghouse 2-phase, 60-cycle, 1040 volt revolving field alternator operated at 900 r.p.m. A standard Westinghouse switchboard is provided with 3 motor-generator panels, 2 alternating-current and 1 direct-current generator panels, 6 feeder panels and 1 load panel, 2 blank panels providing for future extensions. The six feeder panels control six circuits, as follows:

No. 1. New erecting shop, 120-ton crane and transfer table.
No. 2. Carpenter shop, blacksmith shop, new boiler shop and tank shop motors.
No. 3. Roundhouse turntable, machine shop, coal pocket and ash-pit motors.
No. 4. All line-shaft motors.
No. 5. Individual drive motors.
No. 6. Motors in power house for coal-conveying apparatus.

Each feeder panel is also provided with switches for controlling the various lighting circuits.

Current is transmitted by cables through a large tunnel to the new erecting shop, and thence through underground conduits to the various buildings. The Westinghouse three-wire system of distribution is used for lighting and power, with an electro-motive force of 250 volts between the outside wires and 125 volts between each outside wire and the neutral. There is a decided advantage in the flexibility of the voltage, as incandescent and Cooper-Hewitt lamps are operated on the 125-volt sides of the system and constant-speed, 250-volt motors are connected to the main or outside wires, while the variable speed motors utilize shunt field control.

The old erecting shop utilizes both group and individual drive, the group driven machines being divided into five sections, and operated by five type S constant speed motors, two of 30 h. p. capacity and three of 50 h. p. capacity. The machines in the fitting shop, which occupies one wing of the erecting shop, are also group driven by a Westinghouse 30-h.p. constant speed, type S, motor. A complete list of the machine tools operated in each section is given below:

SECTION 1.—50-H.P., CONSTANT SPEED, TYPE S MOTOR.

Wheel press, 100 tons capacity.	Vertical boring mill, 53 in.
Wheel press, 300 tons capacity.	Vertical boring mill, 42 in.
Car wheel borer.	Vertical boring mill, 37 in.
Double car axle lathe.	Upright drill, 36 in.
Single car axle lathe.	Upright drill, 28 in.
4-Spindle drill.	Pillar shaper, 24 in.
Horizontal boring machine.	Planer, 32 x 32 in. x 8 ft.
Engine lathe, 24 in.	Turret lathe, 1½ x 24 in.
Driving wheel lathe, 80 in.	Quartering machine, 90 in.
Two 16-in. engine lathes.	Duplex emery grinder.
Engine lathe, 18 in.	7-Spindle nut tapper.
Engine lathe, 15 in.	Upright drill, 40 in.
Slotter, 10 in.	Small flange punch.
No. 4 plain milling machine.	

SECTION 2.—30-H.P., CONSTANT SPEED, TYPE S MOTOR.

Planer, 60 x 60 in. x 19 ft.	Slab milling machine.
Radial drill, 5 ft.	Drilling, facing and tapping machine, 40 in.
Radial drill, 4 ft.	Duplex emery grinder.
Slotter, 18 in.	Triple head slotter.
Two 2-in. double bolt cutters.	Upright drill, 40 in.
Staybolt cutter, 1½ in.	Two 16-in. engine lathes.
Slotter, 12 in.	One 1½-in. bolt pointer.
2-Spindle centering machine.	

SECTION 3.—50-H.P., CONSTANT SPEED, TYPE S MOTOR.

Planer, 42 x 42 in. x 18 ft.	Horizontal boring machine.
Ring turret lathe.	Engine lathe, 14 in.
Upright drill, 48 in.	Two 16-in. engine lathes.
Engine lathe, 42 in.	Vertical boring machine, 42 in.
Engine lathe, 30 in.	Upright drill, 40 in.
Engine lathe, 24 in.	Planer, 32 x 32 in. x 8 ft.
Crank planer, 20 x 20 x 24 in.	Radial drill, 5 ft.
Turret lathe, 2 x 26 in.	Double-head traverse shaper.
Engine lathe, 36 in.	No. 4 plain milling machine.
Engine lathe, 36 in.	Engine lathe, 26 in.
Horizontal boring machine.	Engine lathe, 30 in.

SECTION 4.—50-H.P., CONSTANT SPEED, TYPE S MOTOR.

Engine lathe, 16 in.	Cylinder boring machine.
Engine lathe, 24 in.	No. 17 Landis grinding machine.
Pillar shaper, 24 in.	Vertical boring machine, 42 in.
Friction drill.	Upright drill, 36 in.
Planer, 36 x 36 in. x 10 ft.	Upright drill, 28 in.
Planer, 36 x 36 in. x 8 ft.	Upright drill, 48 in.
Planer, 32 x 32 in. x 8 ft.	Engine lathe, 36 in.
Engine lathe, 20 in.	Engine lathe, 30 in.
Engine lathe, 18 in.	2-Fox turret lathes.
Engine lathe, 16 in.	Vertical boring machine, 86 in.
Engine lathe, 24 in.	Duplex emery grinder.

SECTION 5.—30-H.P., CONSTANT SPEED, TYPE S MOTOR.

Turret lathe, 2x26 in.	Key slot milling machine.
American brass lathe, 20 in.	Engine lathe, 30 in. piston rods.
Engine lathe, 24 in.	Planer, 36 x 36 in. x 10 ft.
Slotter, 18 in.	

FITTING SHOP—30-H.P., CONSTANT SPEED, TYPE S MOTOR.

Upright drill, 28 in.	Upright drill, 40 in.
Arbor press, 30-ton.	Arbor press, 15-ton.
Planer, 36 x 36 in. x 8 ft.	2-Spindle centering machine.
Vertical boring machine, 37 in.	Buffing wheel.
Three 18-in. engine lathes.	Small emery grinder.
Engine lathe, 16 in.	Surface grinder.
Engine lathe, 30 in.	Guide grinder.
Bench speed lathe, 11 in.	Polishing tape and wheel.
Pillar shaper, 24 in.	Swing grinder.
Crank planer, 20x20x24 in.	Friction drill.

In addition to the group-driven machines in the erecting shop there are a number of individually driven machines operated by both constant and variable speed Westinghouse Type S motors, as follows:

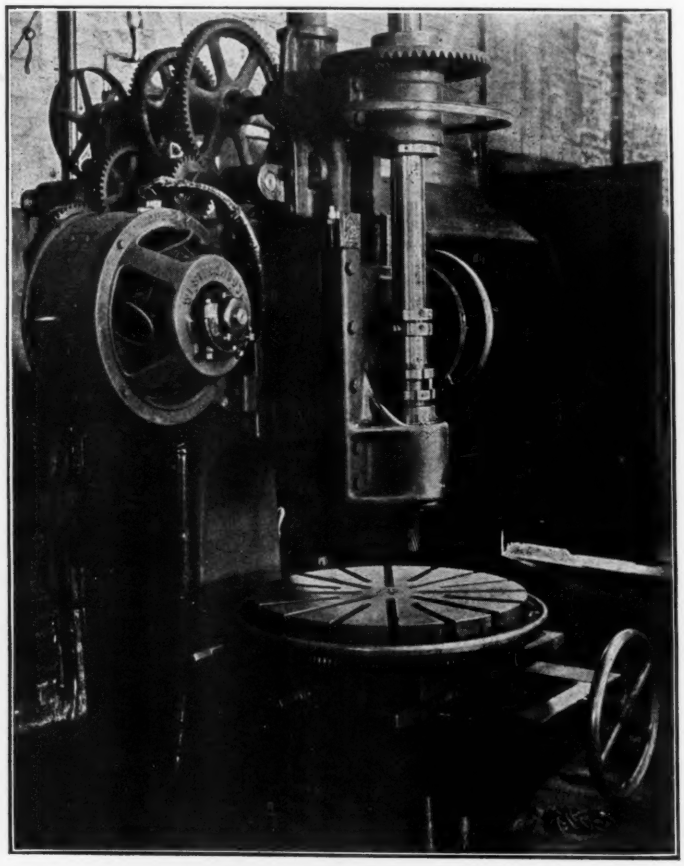
CONSTANT SPEED MOTOR-DRIVEN MACHINES.

One 20-h.p. motor driving a planer.
One 13-h.p. motor direct connected to 600-ton wheel press.
One 7½-h.p. motor for moving tail-stock of driving wheel lathe.

VARIABLE SPEED MOTOR-DRIVEN MACHINES.

One 7½-h.p. motor operating vertical miller for side rods.
One 20-h.p. and one 6-h.p. operating 90-in. boring mill.
One 20-h.p. motor operating driving axle lathe.
One 7½-h.p. motor operating crank pin lathe.
One 40-h.p. motor operating 90-in. driving wheel lathe.
One 25-h.p. motor driving truck tire lathe.

With the variable speed motors it is possible to increase the output, as the time and labor necessary to shift belts or



MOTOR-DRIVEN VERTICAL MILLING MACHINE.

change mechanical speed devices is minimized, and a piece of work can be machined continuously from the smallest to the largest diameter without interruption.

The speed of these motors is controlled by varying the field strength, and, as this may be done while the machine is in operation, it affords an easy and convenient method of speed regulation always under the immediate control of the operator, the controller being conveniently placed within his reach. The variation of field strength is effected by means of a resistance placed in the shunt field circuit of the motor, which decreases the shunt field current and causes a decrease in the field strength and an increase in speed, producing an extremely simple and effective means of varying the speed of either a shunt or a compound-wound motor.

One of the most prominent characteristics of this method of control is the simplicity and low cost of control apparatus made possible by the extremely small current which is handled. A second marked characteristic is the increase of speed with decrease of torque, when used as an adjustable speed motor, the horse-power output remaining practically constant throughout the whole speed range, which makes it peculiarly adapted to machine tool driving. This system involves the use of a minimum amount of auxiliary apparatus, thus materially reducing the first cost of an installation. The regulation of motors operating by shunt field control is good, which is of special importance in the operation of machine tools and in service of any class where constant speed is desirable and where the torque varies between wide limits. The efficiency of motors operating at variable speeds remains practically constant over the range of speed.

The list of machine tools and motors for the other departments is as follows:

TOOL ROOM—20-H.P., CONSTANT SPEED, TYPE S MOTOR:

Yankee twist drill grinder.	Crank planer, 15x15x20 in.
Duplex emery grinder (8-in. wheels).	Lathe, 16 in.
No. 4 universal milling machine (Brown & Sharpe).	No. 3 Landis universal grinding machine.
No. 4 universal milling machine (Cincinnati Milling Machine).	Sellers tool grinder.
	Reamer and cutter grinder.
	Gardner disc grinder.

CARPENTER SHOP—50-H.P., CONSTANT SPEED, TYPE S MOTOR.

Hollow chisel mortiser and boring machine.	Rip saw, 12 in.
Gaining machine.	Hand saw, 42 in.
2-Spindle shaper.	Cutting-off saw, 12 in.
Moulding machine.	Single horizontal borer.
Daniels' planer, 24x14 in. x 9 ft.	Tenoning machine.
Plain mortiser and borer.	Turning lathe, 15 in.
Planer, 8x14 in., 3 cutters.	Swing vertical borer, 15 in.
Rip saw, 18 in.	Pipe cutter, 4 in.
	Pipe cutter, 3 in.

BLACKSMITH SHOP—30-H.P., CONSTANT SPEED, TYPE S MOTOR.

2-Power hammers.	Bolt header, 2½ in.
Light bar shear.	Alligator shears.
Small bolt header.	Bar iron shears.
Bolt header, 1½ in.	Hot saw.

50-h.p. constant speed type S motor direct connected to No. 9 Sturtevant fan.

BOILER SHOP—7½-H.P., CONSTANT SPEED, TYPE S MOTOR.

Two Hartz flue welding machines. Two flue cutting machines.

DIRECT-DRIVEN MACHINES OPERATED BY CONSTANT SPEED, TYPE S MOTORS

One 7½-h.p. motor driving 20 in. punch and shears.
One 25-h.p. motor operating plate rolls.
One 10-h.p. motor operating horizontal punch.
One 7½-h.p. motor driving bevel shears.
One 10-h.p. motor operating 36 in. punch and shears.

In connection with the boiler shop equipment there is a flue rattler, located outside the building, and operated by a 20-h.p. type S motor. It is 48 ins. in diameter and 22 ft. long, and has a capacity of 175 to 200 flues. An average of five lots per day are cleaned, the exact time for each rattling depending upon the water used in the boilers. The longest flue is 21 ft., and they vary from 1½ to 2½ ins. in diameter.

TANK SHOP—20-H.P., CONSTANT SPEED, TYPE S MOTOR.

Single shear, 36 in.	Single punch, 36 in.

In addition to the belt-driven machines there is a 10-h.p. and a 15-h.p. constant speed type S motor geared to a plate roll.

ROUNDHOUSE MACHINE SHOP—20-H.P., CONSTANT SPEED TYPE S MOTOR.

Engine lathe, 16 in.	Upright drill, 40 in.
Engine lathe, 26 in.	Duplex emery grinder.
Planer, 32x32 in. x 8 ft.	Arbor press, 15-ton.
Pillar shaper, 24 in.	

MISCELLANEOUS APPLICATIONS.

One 70-h.p. Westinghouse type S constant speed motor driving fan for round house heating system.
One 10-h.p. Westinghouse type S constant speed motor driving fan for new erecting shop heating system.
One 7½-h.p. variable speed Westinghouse type S motor operating round house turntable.
One 50-h.p. constant speed motor operating coal conveyer in locomotive coaling station.
One 30-h.p. constant speed Westinghouse type S motor operating ash conveyor for removing ashes from locomotive ashpit.
One 7½-h.p. Westinghouse motor operating alligator shears for cutting up sheet iron. This installation is located at the scrap bins in the shop yards.
One 25-h.p. motor operating transfer table.

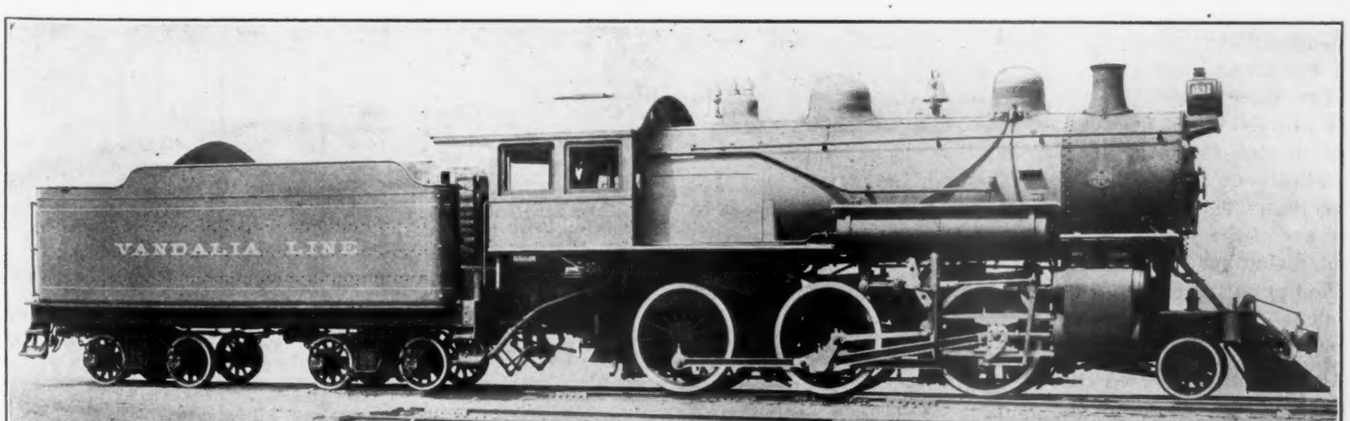
The preliminary studies and final report, showing the benefits which would be the result of electrically equipping these shops, were made by the Westinghouse Electric & Manufacturing Company in conjunction with the motive power department of the Erie Railroad. The results have more than borne out the promises made to the management. The installation of the new electrical equipment presented many engineering problems, but the work of transformation was carried on without any interruption to the service, and it reflects great credit to the contractors, Westinghouse, Church, Kerr & Company, who installed the plant, and Mr. George T. Depue, master mechanic of the Erie Railroad Company, who has charge of the Hornell shops.

HEAVY MOGUL FREIGHT LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

VANDALIA RAILROAD.

The American Locomotive Company has recently delivered an order of three very heavy Mogul freight locomotives to the Vandalia Railroad, one of which is illustrated herewith. These the heaviest weight on three coupled drivers of any locomotives ever built by this company. This exception, however, does not include the Mallet articulated compound built for the Baltimore & Ohio Railroad, which has two sets of three coupled drivers, and gives an average weight of 55,700 lbs. per axle. The Mogul engines have a weight per axle of 53,100 lbs., and a total weight of 187,000 lbs.

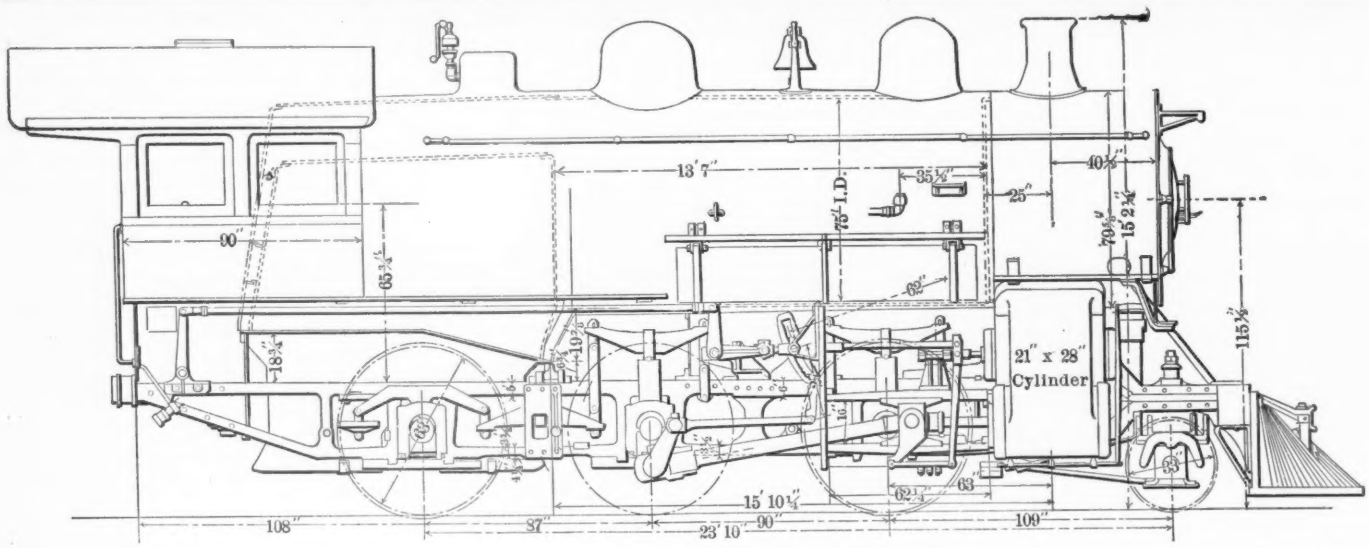
A few years ago the 2—6—0 type locomotive was very pop-



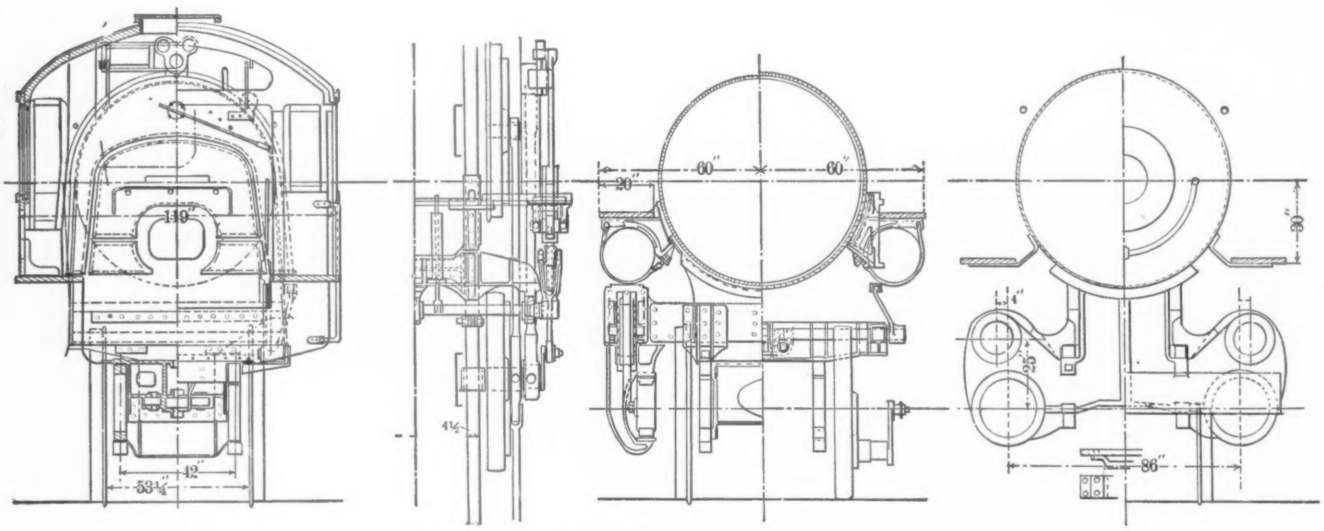
2—6—0 TYPE FREIGHT LOCOMOTIVE WITH WALSCHAERT VALVE GEAR—VANDALIA RAILROAD.

locomotives are the heaviest of their type ever built, and with the exception of some six-wheel switching engines recently built for the Pittsburgh & Lake Erie Railroad, which were illustrated in this journal in September, page 346, they have

ular in many sections of the country for freight service, but recently with the general demand for the heaviest possible locomotives that track and bridge conditions would permit there have been comparatively few of this type ordered. The



SIDE ELEVATION OF 2—6—0 TYPE LOCOMOTIVE—VANDALIA RAILROAD.



SECTIONS AND PLAN OF VALVE GEAR, 2—6—0 TYPE LOCOMOTIVE—VANDALIA RAILROAD.

type should not by any means be considered obsolete, and within its limits, for freight service it probably offers the best possible arrangement of boiler and machinery for the power developed.

The accompanying table shows locomotives of the four different types now in general use for freight service, each example of which has approximately the same tractive effort. A study of the table, giving particular attention to the important ratios, will show that the 2—6—0 type is not out of the race. This particular example, of course, is very heavy on drivers and has a very large boiler.

The three locomotives in this order which are known in the railroad company's classification as Class VF5A, are similar in size, dimensions and general arrangement to 18 other locomotives, Class VF5, which have been in service since 1903 and 1904. The differences made in this later order consist in the use of the Walschaert valve gear instead of the Stevenson and piston instead of slide valves. These changes have resulted in an increase of weight, making them 4,500 lbs. heavier than the previous class.

These engines have been designed for use in mixed service, although it is expected that they will operate principally in freight service on the St. Louis division between Indianapolis and East St. Louis, which division is single tracked, with a maximum grade of 1 per cent., and a greater part of the freight traffic is moved over it as fast freight. Of the 18 engines in the Class VF5 nine were used in passenger service during the year 1904 and nine in freight service. The latter made an average of 50,163 miles and a maximum of 58,611 before receiving general repairs, and the former nine made an average of 75,858 miles and a maximum of 94,658 miles. The three locomotives with Walschaert valve gear have now been in operation four months, and are reported to be giving very satisfactory service. They ride somewhat better than the previous engines, due to the slightly increased weight on the engine truck and front drivers, and work smoother at higher speeds.

Type	2-6-0	2-8-0	4-6-0	2-6-2
Owner	Vandalia.	B. & M.	C. P. R.	N. P.
Tractive effort, lbs.	33,300	33,400	33,300	33,300
Total weight, lbs.	187,000	170,000	190,000	209,500
Weight on drivers, lbs.	159,300	148,000	141,000	152,000
Weight per driving axle, lbs.	53,100	37,000	47,000	50,666
Diameter, drivers, ins.	63	61	63	63
Size cylinders, ins.	21x28	20x30	21x28	21x28
Steam pressure, lbs.	200	200	200	200
Total heating surface, sq. ft.	2,935	2,861	2,413	2,726*
Grate area, sq. ft.	52	46.5	49.5	43.5
Length of flues, ft. & ins.	13-7	16	14-2⅞	15-11*
Driving wheel base, ft. & ins.	14-9	17	14-10	11
Total wheel base, ft. & ins.	23-10	25-6	26-1	28-11
Weight on driv. ÷ total weight per cent.	85.2	87	74.2	72.5
Weight on driv. ÷ tractive effort	4.77	4.43	4.24	4.57
Total weight ÷ tractive effort	63.8	59.4	78.7	76.6
Total weight ÷ total heating surface	5.6	5.1	5.7	6.3*
Firebox H. S. ÷ total H. S. per cent.	6.15	5.03	7.45	7.8*
Tractive effort x diam. driv. ÷ total heating surface (B. D.)	715	711	870	762*

*The boiler of this locomotive has a combustion chamber 32 ins. long, but for the purpose of getting a more accurate comparison with the other locomotives not so fitted, it has been assumed that this space is filled with flues in the usual manner.

Although the length of service has not yet been sufficient to prove whether the advantages of the Walschaert valve gear are sufficient to warrant its general application to this type of locomotive, still its application in this case can be taken as an indication that the advantages of a valve gear outside of the frame are being appreciated, since with this type of locomotive a simple form of Stevenson gear without complications is permissible.

The Walschaert gear is designed to give straight line motion with the combination lever on the outside of the guides, and the valve chamber is set 4 ins. outside of the center of the cylinder for this purpose. The lifting arm connects to the radius rod through a slip joint, making a very simple and satisfactory arrangement. The extension of the valve stem is guided by a support from the top guide bar.

A study of the illustrations will make clear the other details of the locomotive, which as a type has been the standard freight locomotive on this road since 1896. The general dimensions, weights and ratios are as follows:

SIMPLE MOGUL FREIGHT LOCOMOTIVE.

VANDALIA RAILROAD.

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bituminous coal
Tractive effort	33,300 lbs.
Weight in working order	187,000 lbs.
Weight on drivers	159,300 lbs.
Weight on leading truck	27,700 lbs.
Weight of engine and tender in working order	333,000 lbs.
Wheel base, driving	14 ft. 9 in.
Wheel base, total	23 ft. 10 in.
Wheel base, engine and tender	56 ft. 10¼ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.77
Total weight ÷ tractive effort	5.6
Tractive effort x diam. drivers ÷ heating surface	715
Total heating surface ÷ grate area	56.5
Firebox heating surface ÷ total heating surface, per cent	6.15
Weight on drivers ÷ total heating surface	54
Total weight ÷ total heating surface	63.8
Volume both cylinders	11.2 cu. ft.
Total heating surface ÷ vol. cylinders	262
Grate area ÷ vol. cylinders	4.65
CYLINDERS.	
Kind	Simple
Diameter and stroke	21 x 28 in.
VALVES.	
Kind	Piston
Greatest travel	6 in.
Outside lap	1¼ in.
Inside clearance	⅛ in.
Lead in full gear	3/16 in.
WHEELS.	
Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	9½ x 12 in.
Driving journals, others, diameter and length	9½ x 12 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6½ x 12 in.
BOILER.	
Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	76⅝ in.
Firebox, length and width	108⅛ x 69¼ in.
Firebox plates, thickness	C-7/16, T-½, S. & B. ⅜ in.
Firebox, water space	F-4½, S. & B. 4 in.
Tubes, number and outside diameter	390-2 in.
Tubes, length	13 ft. 7 in.
Heating surface, tubes	2,754.6 sq. ft.
Heating surface, firebox	180.4 sq. ft.
Heating surface, total	2,935 sq. ft.
Grate area	52 sq. ft.
Smokestack, diameter	16 & 17½ in.
Smokestack, height above rail	15 ft. 3 5/16 in.
TENDER.	
Tank	Water bottom
Frame	2-12 in. & 2-10 in. channels
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	7,500 gals.
Coal capacity	13 tons

It is not how well a man can do the work himself, but how well he can direct others to do it.—*Paul R. Brooks, before the New York Railroad Club.*

RAPID UNLOADING.—The steamer Powell Stackhouse with a cargo of 9,700 tons of soft coal was unloaded recently at the docks of the Milwaukee Coke & Gas Company by two Brownhoist steam rigs equipped with 2-ton grab buckets in 39 hours actual working time, an average of 249 tons per hour, or 124½ tons per hour per rig. The unloading of the entire cargo, including the cleaning up, was done by grab buckets, and for the first ten hours each machine averaged 160 tons per hour.

GRINDING LATHE AND PLANER TOOLS.

The matter of correctly grinding tools is one that is receiving more and more attention in the better organized shops, where the importance of systematically caring for the cutting tools is fully appreciated. Tool grinding is considered just as much of a department or specialty as the operation of any machine or the maintenance of any department. To have the machine tool operators constantly leaving their machines to sharpen tools is no longer considered the best practice.

There are many excellent reasons for making a department for this class of work. In the first place, the matter of establishing and maintaining correct grinding angles for the various tools is of the utmost importance, in order that they may turn out a maximum amount and high grade of work. It is a well-known fact that there are certain angles for every tool that will produce the best results, and it is practically impossible to maintain these angles unless some method is followed in grinding the tools, and whereby a department is made responsible for the maintenance of such angles. Tools cannot be ground and the best results obtained by the old method of every operator doing his own grinding. While many operators are very skillful in shaping cutting tools, yet the time of such men is much more valuable in operating the machine than in sharpening the tool, especially where the cutting tool can be correctly ground by machine. Tool grinding does not call for the most expert work when done on a tool grinder that is simple in its operation.

Leaving a machine tool idle in order to grind tools means not only a loss in output, but a considerable increase in the cost of the article produced. As the expense to the company, including surcharges, for a machine and operator usually averages about one dollar per hour, the importance of forming a department for the maintenance of the cutting tools is apparent. Under the old system there is the further difficulty of the operator not being able to use the grinder immediately, but having to stand in line waiting for two or three others to finish before he can use it.

GISHOLT TOOL GRINDER.

Other excellent reasons for the establishment of a tool grinding system may briefly be enumerated as follows:

Will grind tools more quickly.

Gives tools that are correctly ground.

Tools cut better—faster.

Increases the output of machine tools.

Machine ground tools are easier to sharpen.

Comparatively cheap labor may be used for grinding them.

Does away with having a lot of unused tools lying about and getting lost.

Makes it so simple to get sharp tools that there is no excuse for the workmen using dull ones and consequently injuring the output.

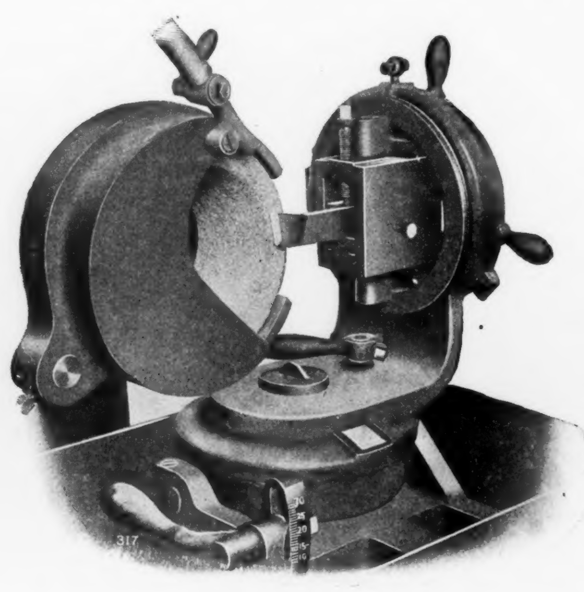
Makes an annual saving in dollars and cents that will cover the cost of the grinder in a surprisingly short time.

To meet the requirements for a moderate priced tool grinder and a machine that will grind lathe and planer tools quickly and accurately, the Gisholt Machine Company of Madison, Wis., has placed on the market the machine illustrated herewith. This grinder is not a new machine, a large number of them being in operation both in this country and in Europe.

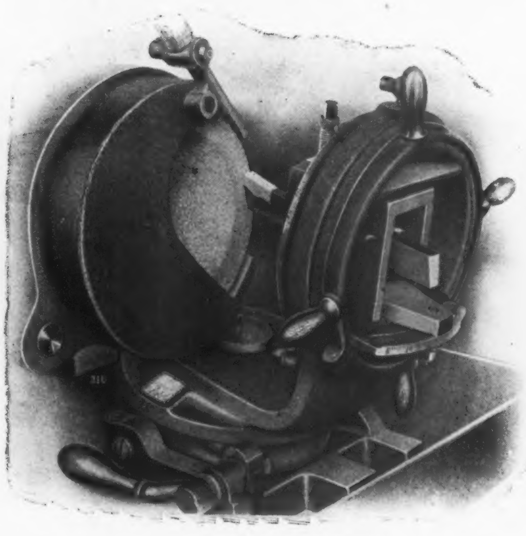
The machine is a simple one to operate. Briefly described, there is a cup emery wheel mounted directly on the spindle of the machine. Just below this is a large pan. Mounted in the pan is a tool holder in which the tool is clamped the same as it would be in the lathe or planer. This pan has two movements—one to and from the main column of the machine, actuated by a hand wheel—the other an oscillating motion of the pan about the axis of the hand wheel, for traversing the tool across the face of the wheel. This motion is obtained by an up-and-down movement of the handle shown to the right of the pan. In order to obtain the correct angles for the standard lathe and planer tools, the Gisholt Company has prepared a chart giving the correct angles, which is sent out with each tool grinder. They also provide, when desired, a set of fifty-seven sample tools correctly ground, for guidance in grinding and in forging.

The first operation in grinding a tool is to clamp it in the tool holder as shown in the illustration. This tool holder has a universal movement, so that the tool may be set to get the proper angle on the side, end, top or face as the case may be. There are four graduated scales. Reference to the chart gives the various angles required for a given side, and upon being set to these angles the tool is traversed up to the wheel by means of the hand wheel which is operated by the left hand. The tool is traversed across the face of the wheel by means of the lever operated by the right hand. It is not removed from the tool holder until all the faces are ground.

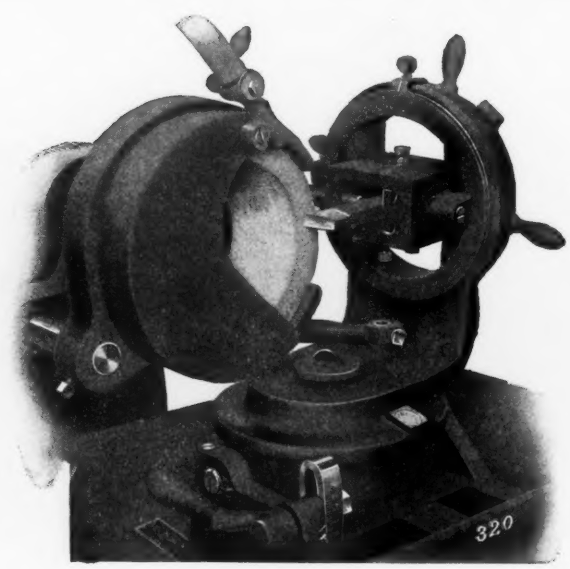
FIRST OPERATION.



SECOND OPERATION.



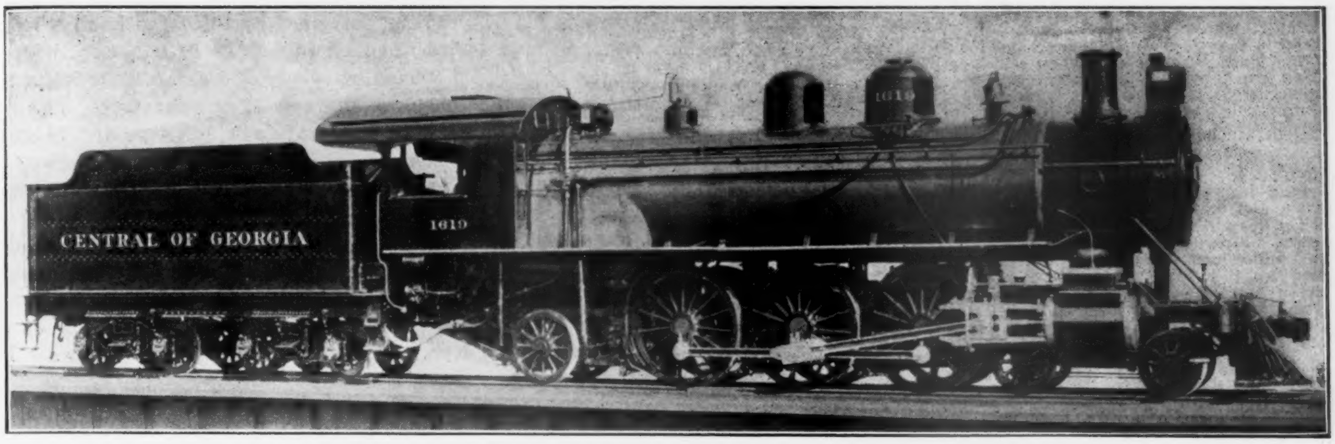
THIRD OPERATION.



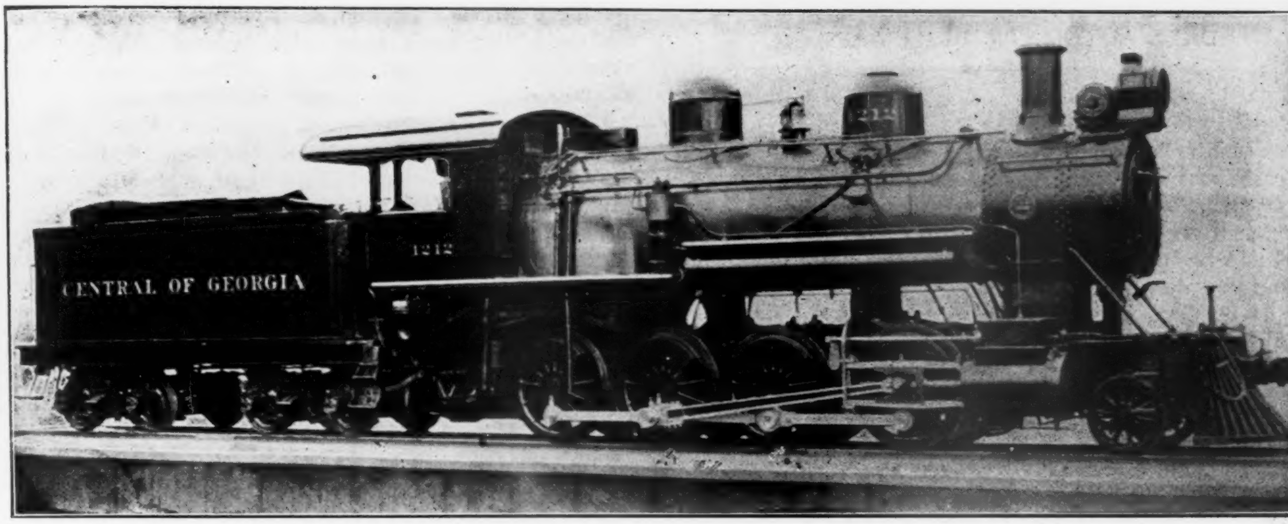
FOURTH OPERATION

Another important matter in handling the tool problem is the question of correct forging. In order to assist the smith in getting the correct shapes, a set of blocks known as formers are furnished with each Gisholt grinder. By the use of these nearly all of the usual shapes of lathe and planer tools may be formed, thus reducing the time required for forging to a minimum.

The Vanderbilt system of railroads comprises 21,353 miles of line and the Hill system 20,242 miles.



PACIFIC TYPE PASSENGER LOCOMOTIVE—CENTRAL OF GEORGIA RAILWAY.



CONSOLIDATION TYPE FREIGHT LOCOMOTIVE—CENTRAL OF GEORGIA RAILWAY.

PASSENGER AND FREIGHT LOCOMOTIVES.

CENTRAL OF GEORGIA RAILWAY

The Central of Georgia Railway has recently received from the Baldwin Locomotive Works an order of ten Pacific and fifteen consolidation type locomotives. The former are designed for passenger service, and have a tractive effort of 28,000 pounds. As the weight on the driving wheels is 113,660 pounds the factor of adhesion is 4.06. These engines are well proportioned throughout, and have ample boiler power for the service required of them.

The boiler is of the straight top design, with sloping throat sheet and back head. The barrel is supported by the guide bearer sheets and two intermediate waist sheets. The fire-box is carried at each end on buckle plates bolted to cross ties. Both injectors are located on the right side, and feed through a double check valve placed on the top of the boiler close to the front tube sheet.

The cylinders are equipped with slide valves, actuated by the Stephenson link motion. The rock shaft is placed immediately in front of the leading pair of driving wheels, and is connected to the link block by a transmission bar, which spans the leading driving axle.

The frames are of cast steel, with double front rails and separate rear sections. The rear truck is of the Rushton type, with inside journals.

The tender frame is built of 12-inch steel channels. The tank is U-shape, with a water bottom and a sloping floor in the fuel space.

In the consolidation engines the details are as far as possible interchangeable with those of the Pacific type. The tractive effort is 34,000 pounds, and the factor of adhesion is 4.21. The boilers are of the wagon top design, and are smaller than those used on the passenger locomotives. The fire-boxes are supported in a similar manner.

On these freight locomotives the link is suspended immediately back of the second driving axle, and the rock shaft is between the first and second pairs of driving wheels. The transmission bar passes above the intermediate axle. The leading truck is equalized with the first and second pairs of driving wheels. The third and fourth pairs of wheels are equalized by beams placed over the boxes and connected through an inverted leaf spring. Coiled springs are used to support the frame at the other ends of the beams.

The tender is similar to that used on the Pacific type locomotives, although the fuel and water capacity is less.

The general weights, dimensions and ratios of both classes are as follows:

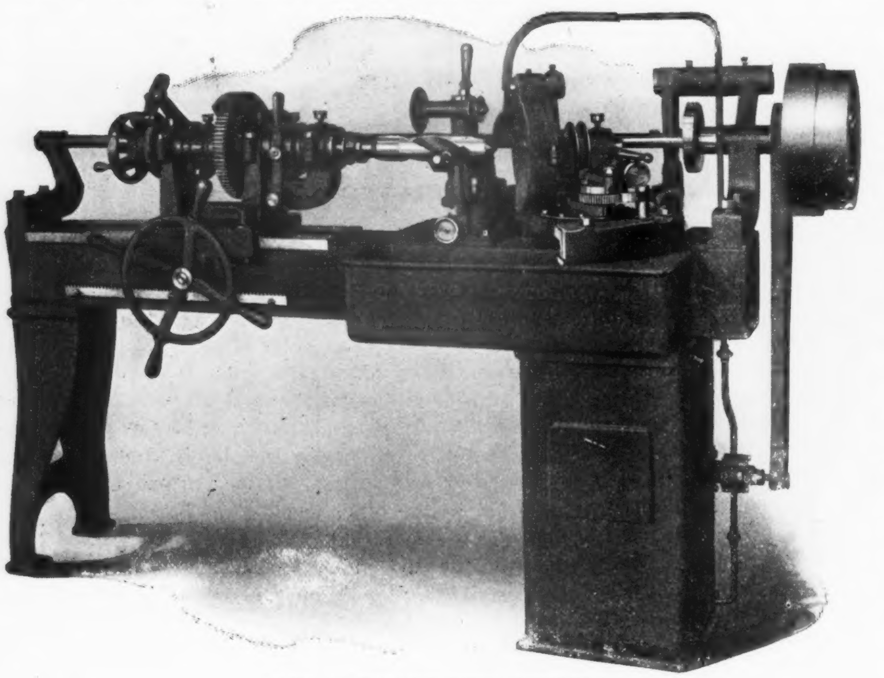
GENERAL DATA.		
Type	4-6-2	2-8-0
Service	Pass.	Frgt.
Fuel	Bit. Coal.	Bit. Coal.
Tractive effort	28,000 lbs.	34,000 lbs.
Weight in working order	187,860 lbs.	163,390 lbs.
Weight on drivers	113,660 lbs.	143,290 lbs.
Weight on leading truck	37,300 lbs.	20,100 lbs.
Weight on trailing truck	36,900 lbs.	....
Weight of engine and tender in working order	335,000 lbs.	283,000 lbs.
Wheel base, driving	11 ft. 10 in.	16 ft.
Wheel base, total	30ft. 4½ in.	24ft. 3½ in.
Wheel base, engine and tender	58ft. 5½ in	53ft. 9 in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.06	4.21
Total weight ÷ tractive effort	6.7	4.8
Tractive effort x diam. drivers ÷ heating surface	568	825
Total heating surface ÷ grate area	71.8	52.5
Firebox heating surface ÷ total heating surface, per cent	5.05	6.35
Weight on drivers ÷ total heating surface	33.8	62.
Total weight ÷ total heating surface	56.	71.
Volume both cylinders	10.2 cu. ft.	10.2 cu. ft.
Total heating surface ÷ vol. cylinders	331.	227
Grate area ÷ vol. cylinders	4.62	4.33
CYLINDERS.		
Kind	Simple.	Simple.
Diameter and stroke	20x28 in.	20x28 in.
Kind of valves	Bal Slide.	Bal. Slide.

WHEELS.		
Driving, diameter over tires	68 in.	56 in.
Driving, thickness of tires	3 in.	3 in.
Driving journals, main, diameter and length	9x12 in.	8½x10 in.
Driving journals, others, diameter and length	8½x12 in	8½x10 in.
Engine truck wheels, diameter	33 in.	33 in.
Engine truck, journals	5½x10 in.	5½x10 in.
Trailing truck wheels, diameter	42 in.	.. ..
Trailing truck, journals	7½x12 in.	.. ..
BOILER.		
Style	Str.	W. T.
Working pressure	200 lbs.	200 lbs.
Outside diameter of first ring	66 in.	61 in.
Firebox, length ard width	102¾x66 in.	96⅛x66 in.
Firebox, water space	F-4,S&B-3½in	F-4,S&B-3in
Tubes, number and outside diameter	280-2¼ in.	283-2 in.
Tubes, length	19 ft. 5 in.	14 ft. 8 in.
Heating surface, tubes	3188 sq. ft.	2161 sq. ft.
Heating surface, firebox	169.5 sq. ft.	146 sq. ft.
Heating surface, total	3357.5 sq. ft.	2,307 sq. ft.
Grate area	46.8 sq. ft.	44 sq. ft.
TENDER.		
Tank	U.	U
Frame	12 in. chan.	12 in. chan.
Wheels diameter	33 in.	33 in.
Journals, diameter and length	5½x10 in.	5½x10 in.
Water capacity	7,500 gals.	6,000 gals.
Coal capacity	12 tons	8 tons

DAHL AUTOMATIC DRILL GRINDER.

The Dahl automatic drill grinder, illustrated herewith, was developed in Europe and is being introduced and manufactured in this country by Manning, Maxwell & Moore. It works automatically, may be operated by unskilled labor and will grind accurately drills from ½ to 3½ ins. in diameter.

The drill while being ground is fed toward the grinding wheel and revolves slowly. The carriage or head upon which the grinding wheel is mounted has a peculiar motion imparted to it by the large cam on the main shaft, to the left of the driving pulley. This motion is carefully designed to accurately



DAHL AUTOMATIC DRILL GRINDER.

grind the proper clearance. With such an arrangement it is, of course, necessary to have both the drill and the grinding wheel carriage operated positively from the same driving shaft and also to have the drill set accurately. The latter is accomplished by means of the pointer or gauge shown in front of the drill to the left of its cutting end. The grinding wheel head or carriage also feeds slowly back and forth so that the wear on the face of the wheel is uniform. Gauges are placed upon this head for adjusting the wheel for various diameters and there is also a micrometer adjustment for adjusting the wheel as it wears.

The drill chuck is operated by a lever and securely grips the drill, holding it true. Motion is transmitted to the drill spindle by a small gear on the driving shaft which meshes with the large gear shown in the illustration. The drill spindle carriage may be rapidly traversed by the large hand wheel in front or in order to properly adjust the drill before throwing on the power feed it may be slowly and carefully traversed by the small hand wheel at the end of the carriage. The feed arrangement is such as to provide a wide range and to afford a fine adjustment.

After the drills are ground the drill carriage is moved back a short distance and the small emery wheel shown just back of the drill is swung around 90 degs. and the drill is pointed. Both of the grinding wheels are driven from the countershaft by separate belts. The pump, which circulates the water or lubricant contained in the two large pans either side of the grinder head is driven from the driving shaft as shown. The machine weighs about 1,900 lbs.

Labor Conditions on the Panama Canal.—The kind and quality of mechanics it was necessary to depend upon for the first fifteen months were exceedingly annoying, as the men had been gathered up from what had been left by the French, and also from South and Central America, speaking various languages. Within the past year, however, a very good grade, on the average, of American mechanics has been employed. As the mechanics in the United States are finding out that the sanitary conditions on the Isthmus are nothing like as represented by the majority of the current publications, and, further, that such conditions are no worse, and in many instances better, than are found in our own South below the city of Memphis, Tenn., a very satisfactory class of these men have taken up their homes on the Isthmus.

The rates of pay of the various employes are as follows: Steam shovel engineers, $210 per month; steam shovel cranesman, $180; locomotive engineers (construction work), $125; drill runners, $180; trainmen, $100; conductors, $150; foremen of dumps, $125; powdermen, $100; shop foremen, $150 to $175; general foremen, $200 to $225. All monthly employes are transported from New York to Colon free of charge, and their pay commences at the hour when the vessel leaves the pier at New York. In addition, all monthly employes are entitled to six weeks' leave of absence each year with pay, together with the $20 rate to New York, going and coming. They are also still further entitled to 30-day sick leave, with pay in addition when actually sick.

Skilled labor, paid by the hour, is rated as follows: All classes of machinists, boilermakers, blacksmiths and moulders receive 65 cents per hour; plumbers, 75 cents; carpenters, planing mill machine hands, coach cabinet makers, 56 cents; blacksmith helpers and car inspectors and repairers, 44 cents. At the present time the working hours are eight per day. Men employed by the hour are given free transportation from New York, their time of employment commencing when vessel leaves. These are not, however, entitled to any special privileges, such as leave of absence with pay.

Living quarters are furnished to all men arriving on the Isthmus, consisting of a room, with bed, mattress and pillow, but the employes are expected to furnish all linen, blankets and mosquito bar. Excellent board is furnished at the hotels of the Commission at 30 cents per meal, making boarding expenses total about $27 per month.

All hotels and quarters furnished for men are either new, or old French quarters thoroughly and generally overhauled.

Desirable and competent men, who are making up their minds to stay, are encouraged to bring their families down. Comfortable quarters are furnished to each family. New

quarters are being furnished as rapidly as the buildings can be erected. At the present time, all points where American skilled labor is located are being furnished with a good and reliable water supply and a convenient commissary run by the government. A full variety of provisions at a trifling advance over the cost of such provisions in the States can be obtained. The slight extra cost is simply to make the commissary self-supporting.

As regards a man's physical condition, there is no reason why one who is free from any kidney or liver troubles would not be as safe in working on the Isthmus as almost anywhere in our own Southern States. An age limit for skilled mechanics has been established at from 21 to 45 years.

The climatic conditions, while annoying during five or six months of the year, owing to the heavy rains, are troublesome only as regards the work, by causing slides and bad track. While the atmosphere during the rainy season is very humid, this condition is due to moisture from the two oceans and is decidedly different from the humidity in our interior States. Temperature conditions vary in the shade from 80° to 87° Fahr. Under cover a breeze can always be felt, and the use of a blanket after one or two o'clock every night in the year is decidedly necessary. It can thus readily be seen that the average conditions on the Isthmus are such as would favorably appeal to even the most skeptical of American workmen.—*Charles W. Burke, in the Engineering Record.*

A 40-TON STEEL FLAT CAR for carrying boilers, large castings, etc., has recently been built for the Cheshire Lines, of England, and is peculiar in that (like some other English cars for the same purpose) the floor is dropped between the trucks. There are four 9-in. I-beam sills, reinforced by top and bottom cover plates, and having a total length of 46 ft. 9 ins. The two sills on each side are connected at each end by a cross connection, the middle of which is carried in a link or hanger supported from bearings on the truck frame. Cross pieces are riveted between the sills at intervals, and the outer sills have a number of rings for securing the chains or lashings. The height from the rail to the floor is only 20½ ins. The trucks have four wheels 4 ft. 6 ins. diameter, on a wheel-base of 6 ft. 3 ins., and have semi-elliptic springs over the boxes, but the springs are not equalized. Transverse frames or bulkheads prevent the load from fouling the trucks. With a total capacity of 40 tons, the car will carry 25 tons on a length of 12 ft. at the middle. The car is 59 ft. long over the buffers, with trucks 44 ft. 9 ins. c. to c., and 32 ft. clear length of floor. The journals are 5½ x 8 ins. The car is equipped only with a hand brake, and that operates brakeshoes on only one pair of wheels.

FLUCTUATING FORCE UNECONOMICAL.—The industrial world has found that machinery is most economical when continuously operated. The human portion must be considered as one machine in the aggregate. The more uniform it is maintained the greater its efficiency. In a fluctuating force poor men come and good men go. A smaller number of men kept continuously at work under a definite appropriation, which takes full advantage of the long summer days to get equipment in shape for the winter, will show a better annual balance sheet. The reason that expenses go up when the gross receipts do is that they were previously forced down with the gross receipts.—*Paul R. Brooks, before the New York Railroad Club.*

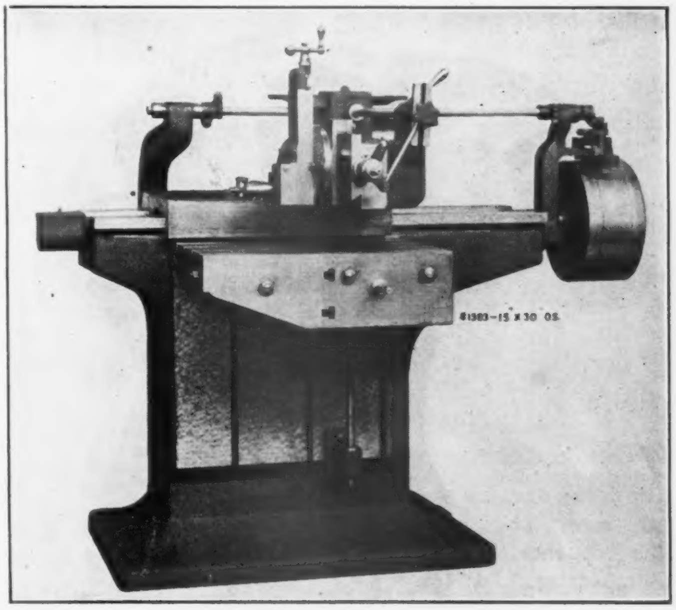
ONE BOILERMAKERS ASSOCIATION.—The International Railway Master Steam Boilermakers Association and the Master Steam Boilermakers Association will meet in joint convention at Cleveland, Ohio, May 21, 22 and 23, 1907, to organize into a single large association of foreman boilermakers. It is expected that the new association will be very much more effective than the separate organizations.

OPEN SIDE SHAPER OR PLANER.

The Cincinnati Shaper Company has recently brought out a line of open side planers, the smallest of which is shown in the accompanying illustration, and planes 15 ins. wide and 30 ins. long. It is of an improved Richards type, and for certain classes of work may be used to better advantage than either a pillar shaper, a traverse shaper or a planer. The leading dimensions of the machine illustrated are as follows:

Length of stroke	30 in.
Width planed	15 in.
Maximum distance head to table	15½ in.
Minimum distance head to table	4½ in.
Vertical adjustment of table	11 in.
Length of table and extension	30 in.
Width of table	18 in.
Depth of table	12 in.
Down movement of tool slide	6½ in.
Ratio of cut to return	1 to 2
Weight of machine and countershaft, net	3,450 lbs.

The machine is driven by a single screw and bronze nut, and without the intervention of gears. The screw is 2⅛ ins. in diameter and is made of .50 carbon steel. The saddle has a long and wide bearing on the column, with a narrow and



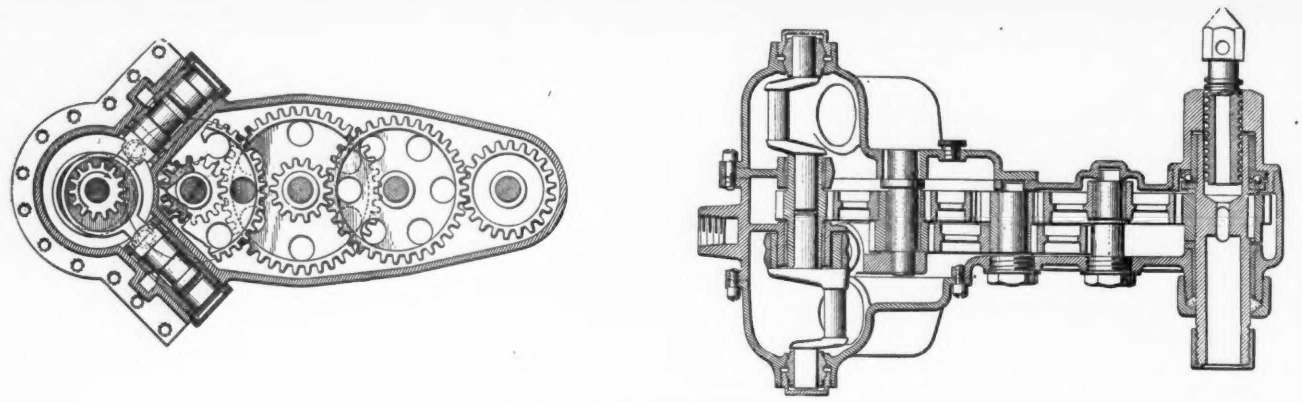
OPEN SIDE SHAPER OR PLANER.

deep guiding surface to prevent binding, especially when the tool is at the outer end of the rail. It is provided with a taper gib lengthwise, adjustable by screws at each end, affording uniform contact on both sides of the gib.

The cross feed by power or by hand, is positive and adjustable. The down feed is by hand. The reversing mechanism is new and a decided improvement over existing methods. It depends on the turning of the shifting rod both for reversing the motion of the saddle and for the automatic cross feed to the head, the rod being automatically turned by cams on the saddle coming in contact with dogs adjustable on the rod, or by hand from the saddle, if desired.

There are ball bearings for the shifting rod, as well as under the table elevating screw. There are taper gibs to the cross rail and to the head. The head has a down feed of 6½ ins., swivels, is graduated, and has a micrometer collar reading to .001 ins. The table raises and lowers by means of a crank handle, not shown. The supplementary table may be removed, to bolt pieces against the side of the table proper, or the table itself removed and pieces bolted directly to the column. Keyseating of shafting of any diameter may be done in the machine. All flat bearings are hand scraped to surface plates, and all tee slots cut from the solid.

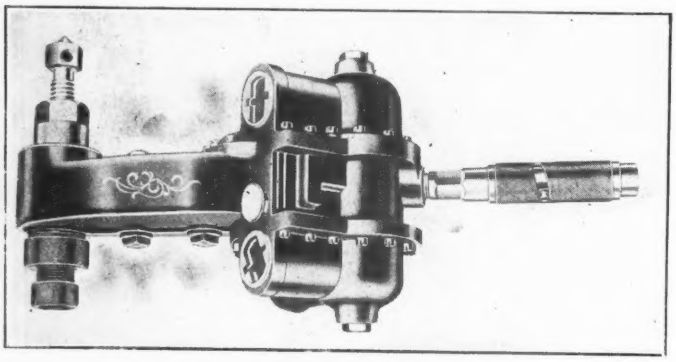
TURBINE STEAMSHIP.—A twin turbine steamer named the "Creole" is being built for the Southern Pacific Company, and will run between New York and New Orleans. This is the first ship of this type to be launched in this country.



DETAILS OF LITTLE GIANT CORNER DRILL.

LITTLE GIANT CORNER DRILL.

The Chicago Pneumatic Tool Company is about to place on the market a "Little Giant" drill designed for drilling in close quarters and especially in corners. It weighs only 35 pounds, and has a capacity for 1½ in. drills, although in an emergency it will drive a 2 in. twist drill with satisfactory results. The spindle speed when running light is 150 r.p.m.; under a load and with 80 lbs. air pressure it operates at 100



r.p.m. The distance from the end of the socket to the end of the screw, when screwed down, is 5⅞ ins.; length of feed 2 ins.; distance from the centre of the spindle to the outside of the housing, 1 5-16 ins.

The accompanying illustrations clearly show the construction of the drill. A steady and uniform spindle movement is insured, due to the use of gears. The various parts of the drill are interchangeable with those of the No. 4 Little Giant drill.

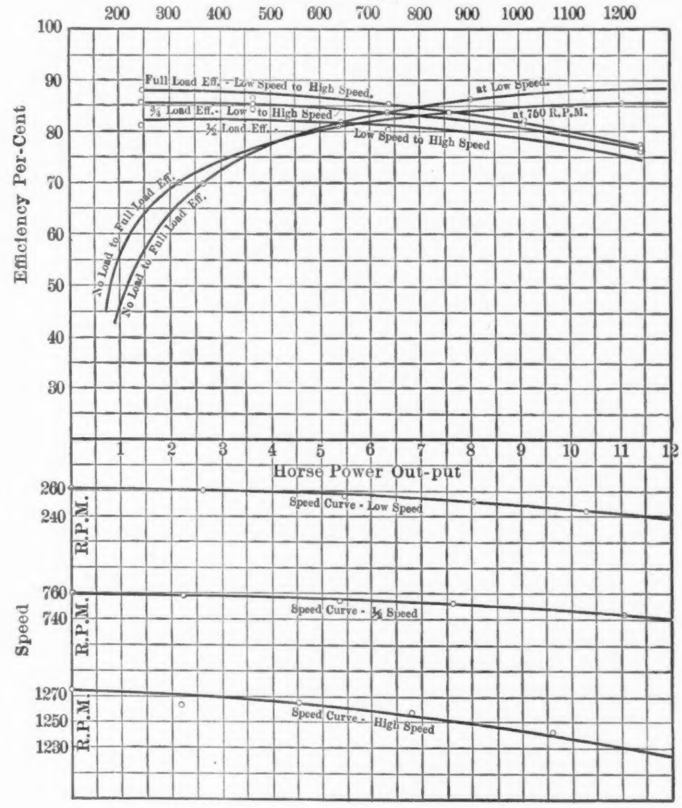
THE AVERAGE WAGES per hour paid in 1905 in 349 occupations in 4,121 establishments were 18.9 per cent. higher than those paid in 1890-99, inclusive, and the average hours of labor per week were 4.1 per cent. lower. The average wages per week in 1905 were 14 per cent. higher than in the same ten-year period, and the total payroll was 52.3 per cent. higher. These figures were recently made public by the U. S. Bureau of Labor, which also states that the retail price of the principal articles of food, weighted according to their consumption in the family, was 12.4 per cent. higher in 1905 than in 1890-99. Therefore the purchasing power on an hour's wages in 1905 was 5.8 per cent. greater than in 1890-99, and of a week's wages 1.4 per cent. greater, the difference between the weekly and hourly figures being due to the reduction of the hours of labor that has taken place lately.—*Engineering Record.*

HIGHER SALARIES IN COMMERCIAL LINES.—Business firms find it necessary to pay more than the railroads customary $2,500 per year for the man to properly administer a payroll and materials expenditure of $50,000 to $100,000 per month.—*Paul R. Brooks, before the New York Railroad Club.*

THE LINCOLN VARIABLE SPEED MOTOR.

In our July, 1906, issue, page 276, we presented a description of the Lincoln variable speed motor. We have just received an efficiency test of one of these 10 h.p., 5 to 1 motors, which is reproduced herewith.

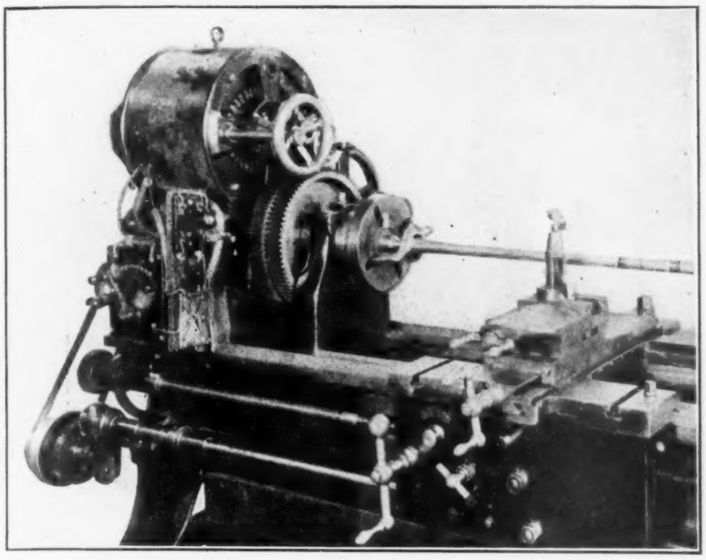
The photograph shows an interesting application of one of these motors to a 22 in. lathe at the American Steel & Wire Company's works, Cleveland, Ohio. The motor is a 3½ h.p., with a speed range of 6 to 1 or 1,800 to 300 r.p.m. It weighs 350 lbs. With the back gears out the lathe has a spindle speed of from 56 to 340 r.p.m., and with the back gears in 9 to 54 r.p.m. The application is neat and compact and the hand wheel, which controls the armature position, thus changing the speed, is placed conveniently for the operator.



TEST OF 10-H.P LINCOLN VARIABLE SPEED MOTOR.

The following claims are made for the motor: Any speed range within reasonable limits may be furnished, thus making it possible to eliminate trains of gearing and mechanical speed changing devices. No controller or resistance is used, thus eliminating a source of trouble. The horse-power is constant at all speeds. Any speed between maximum and minimum may be obtained at will. Only two direct current wires used—the installation being the same as any ordinary constant speed

motor. For a given horse-power and speed range, the motor is very light in weight and compact in size. It maintains a very steady speed under varying loads. It will stand 50% overload throughout the range without sparking. It will carry



APPLICATION OF LINCOLN MOTOR.

50% overload for one hour without heating above safe limits. It runs equally well in either direction. With it a machine tool can be driven continuously at the highest speed that the tool or work will stand. Its efficiency is high, as shown by accompanying diagram.

RESISTANCE OF WOOD TO SHOCK.—Little study has been given to the resistance of wood to the action of impact loads, such as result when a locomotive passes over a wooden trestle. The Forest Service has been studying the subject at the timber-testing station at Purdue University, Lafayette, Ind., and finds that wood is more elastic under impact than under gradually applied loads. This would go to show the wisdom of locomotive engineers in taking a weakened trestle at high speed. Air-dried loblolly pine specimens, both of natural and steamed wood, 2 by 2 ins. in cross section, were tested in bending on a 34-in. span under both impact and static loadings. The moisture content was approximately 13 per cent. of the dry weight, or about the moisture condition of air-dry wood. The maximum deflection under a gradually applied load was 1.2 ins., and the deflection just preceding failure under impact was 1.1 ins. There is, thus, little difference between the ultimate deflection of wood under the two kinds of loading. But at the elastic limit the average deflection under gradual loading was 0.33 in., while the average deflection under impact loading was 0.66 in. Thus this wood possesses twice the elastic strength under impact that it does under static load.—*From Trade Bulletin 11 of the United States Department of Agriculture, Forest Service.*

KNOW THE REASON WHY.—There is another phase of this case which is perhaps worthy of a moment's notice. Given two young men of equal ability, and let both of them go through good technical schools, both graduating as chemists, or as mining, mechanical, civil or electrical engineers. The one during his course of study has covered much ground, has stored his mind with facts, has learned carefully and well the methods and manipulation required in the branch chosen. The other has not covered so much ground, but every bit of information that he has he thoroughly understands; he has acquired principles rather than a large array of facts, and he knows the reason why. Let now these two begin work after graduation in the same place, and we are ready to confess that the former will make the best showing, and progress the more rapidly for the first year or two, but if our observation is worth anything, the latter will distance his competitor at the end of ten years.—*Dr. Chas. B. Dudley.*

FASTEST LONG DISTANCE RUN.

In a letter to the *Railway Age*, Mr. D. C. Moon, assistant general manager of the Lake Shore & Michigan Southern Railway, gives the first authorized account of a very high speed run made on the Lake Shore & Michigan Southern Railway on June 13, 1905, between LaSalle Street Station, Chicago and Exchange Street Depot, Buffalo. The distance is 525 miles and the train, which consisted of a coach and two private cars, made it in 7 hours and 33 minutes, or 453 minutes total elapsed time. Outside of slow running through yards and two grade crossing stops there was a total of 9 minutes lost in changing engines at four different points. This time was the actual time that the train was standing still and does not include any correction for the time lost in slowing down and starting again, hence the total time in which the train was moving, including also the two grade crossing stops, was 444 minutes for the 525 miles, or an average rate of speed of 70.94 miles per hour. The speed including the time for stops was an average of 69.53 miles per hour.

No special arrangements were made in advance for this run except to provide for the dispatchers to see that the way was clear. The speed was noted by a stop watch for many individual miles during the run and it was found that many of them varied from 41 to 45 seconds per mile and the fastest mile noted was 40 seconds or at the rate of 90 miles per hour. Aboard the train at the time, in addition to others, were Mr W. H. Marshall, then general manager of the railroad, Mr. E. A. Handy, then assistant general manager, and Mr. D. C. Moon, then assistant general superintendent. This undoubtedly is the record for speed of railway trains for this distance and its accuracy is without question.

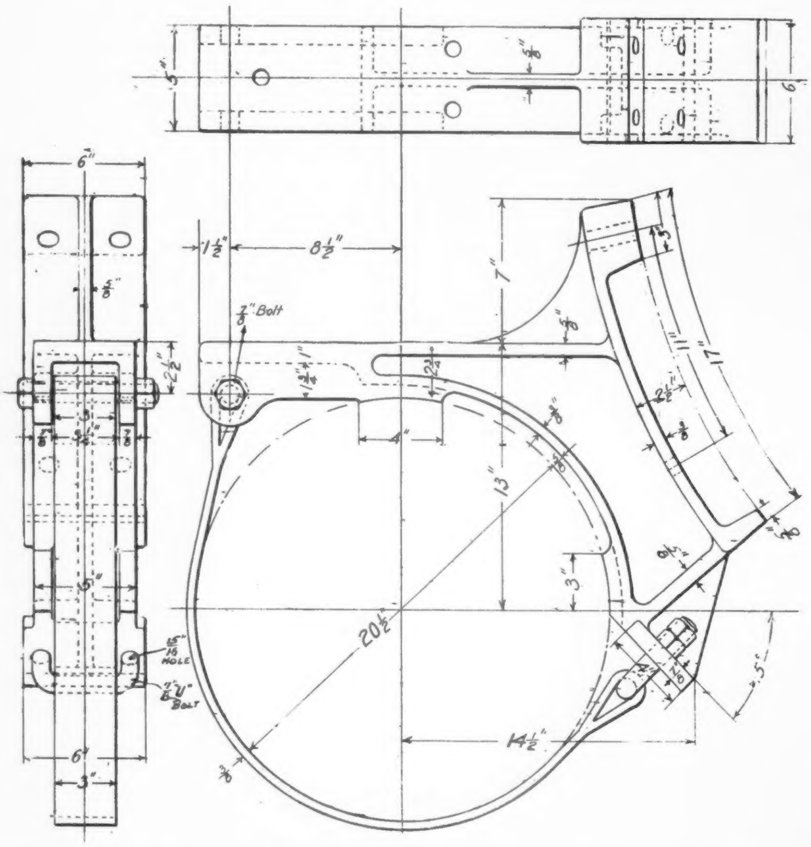
STEAM AUTO-CARS IN ENGLAND.—The North-Eastern Railway Company has greatly extended the employment of steam railway auto-cars, which give a speedier and more economical service than is possible with the ordinary steam driven trains. The auto-cars consist of a light tank passenger engine coupled to a bogie carriage of the company's standard pattern, so altered as to accommodate 50 third-class and eight first-class passengers, with a luggage compartment and driver's compartment. These cars may be operated either from the locomotive or from the driver's compartment at the end of the car by means of suitable gearing and levers, enabling it to be controlled in either direction without turning. The engine cylinders have been reduced so that the lighter load taken may be worked correspondingly cheaper, this alteration having been carried out at the Darlington works. Nineteen of these coaches are now in actual service, but the total stock will be 29 engines and 28 cars. The auto-cars are in service over practically every branch line between the Humber and the Tweed.

HIGH SPEED STEEL AND FINISHING CUTS.—Doubts have arisen at times as to whether high-speed steel would take finishing cuts. In the early stages of its manufacture, such contentions were somewhat justifiable, but with the knowledge gained from its use, together with greater experience and knowledge of its manufacture, the early difficulties have been largely overcome. The writer wishes it to be understood that he does not state that rapid cutting steel will produce a high finish under all conditions, for with certain metals a special carbon alloy steel—suitable for hardening in water, will give greater satisfaction, but on the other hand, there are very many operations where high-speed steel will produce the desired finish, and by reason of greater endurance, continue to work for very much longer periods than water hardening steels, and in such cases there can be no doubt of its advantage for this work. In fact, many instances could be quoted where ordinary steel has failed and been successfully replaced with high-speed steel.—*J. M. Gledhill.*

RUNNING BOARD BRACKET AND AIR RESERVOIR SUPPORT.

A new design of cast steel running-board bracket and air reservoir support is being applied by the American Locomotive Company to some of the recent locomotives built by them. The illustration shows the design as applied to the Mogul locomotives for the Vandalia Line, which are illustrated elsewhere in this issue.

As can be seen in the illustration, this consists of a cast steel bracket fastened to the boiler by four ⅞-in. studs and forming a bearing for the top and inner side of a 20½-in. air reservoir, which is held in place by ⅜ x 3-in. straps. The strap at each bracket is constructed with an eye passing over a ⅞-in. bolt at the outer end of the cast steel bracket and connecting to a ⅞-in. U bolt at the lower end. This U bolt is threaded for a sufficient distance to allow the strap to be drawn up tightly and hold the drum securely in place. By this method the top of the running-board bracket is left entirely clear, and there are no projections extending up through the running-board, as is usually the case with air-drum supports. The illustration will make clear the features of the design.



AIR DRUM SUPPORT AND RUNNING BOARD BRACKET—AMERICAN LOCOMOTIVE CO.

AUTOMATIC ELECTRIC MOTOR DRIVEN PUMPING STATION.

The ease of adapting automatic methods of control to the electric motor makes it most convenient for driving pumping machinery. It is generally a simple matter to arrange a float operated switch to open and close the motor circuit so that the expense of an attendant, necessary with a steam plant, is eliminated, and the pumping set can be erected advantageously in an isolated position. This is especially true along railway lines where, if electric current is available, an automatic electric pumping set may be installed to fill the water supply tanks for the locomotives.

A very successful induction motor driven pumping plant for this purpose is in operation on the lines of the Lake Shore & Michigan Southern Railway at South Bend, Indiana. The pumping outfit consists of two Worthington single-stage turbine pumps, each direct connected to a six-pole, 7½ horse-power, three-phase, 440 volt General Electric Company's induction motor. Two pumping sets are installed, so that in case one set fails, repairs can be made without shutting down the plant. Power for operating the motors is taken from the lines of the St. Joseph and Elkhart Power Company.

In Fig. I is shown a view of the pumping house. This is a round brick structure erected at the top of a concrete lined well. The floor is of concrete, supported by I beams, and is ten feet below the level of the ground. Upon this the pumps are erected, the interior arrangement being shown in Fig. 2. For keeping the pump room dry four ventilating ducts are built into the wall of the pump house, the outlets appearing in the pilasters in Fig. 1.

FIG. 1—ELECTRIC PUMPING STATION.

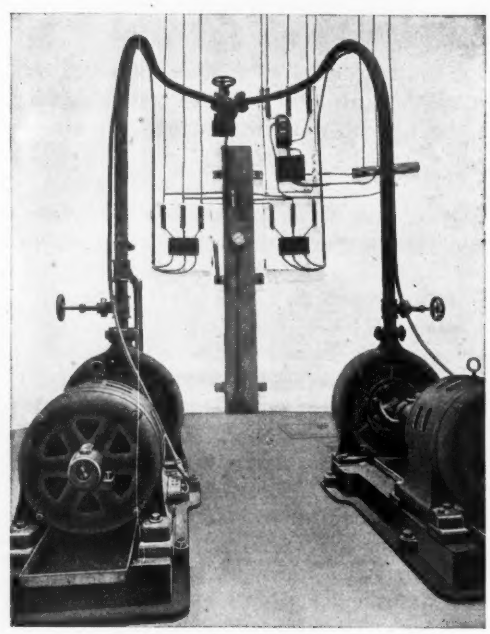
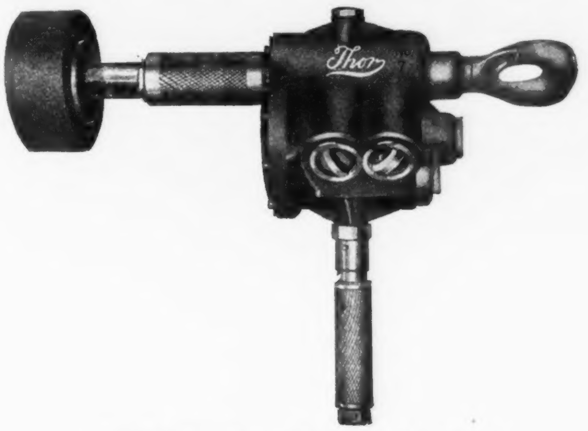


FIG. 2—INTERIOR OF ELECTRIC PUMPING STATION.

Each pump discharges water through a 2½-inch pipe connecting with a 4-inch main, which leads to the supply tank. This tank is located at the side of the tracks, about 100 feet from the pumping station. The controlling device is arranged in the housing on the roof, the motors being started and stopped automatically by a small oil-switch operated by a float, which has a vertical movement of about one foot. This difference in level in the tank corresponds to 3,000 gallons of water. This is the average amount taken by a locomotive, and is replenished by the pumping set in about twenty-five minutes. The supply tank holds about 50,000 gallons, and could supply fifteen locomotives within a few minutes if necessary. However, such a heavy demand will probably never be made, and in actual practice the pumps stand idle for the greater part of the time.

PNEUMATIC GRINDING MACHINE.

A new portable pneumatic grinding and burnishing machine is being manufactured by the Independent Pneumatic Tool Company, Chicago, which apparently fills all the requirements for a machine of that nature. It has a speed of 3,000 revolutions per minute, weighs but 20 pounds and consumes but 20 cubic feet of free air per minute.



THOR PNEUMATIC GRINDING MACHINE.

The motor is of the reciprocating piston type, having four pistons, direct-acting on the crank, and is equipped with a special Corliss type of valve motion, which gives it a surprisingly large amount of power.

The grinding spindle proper is held in the housing extended from the end of the motor in line with the crank shaft. It is not a part of the crank shaft, however, but is connected with it. The grinding spindle itself runs on a combination of ball and plane bearings. There is a large bronze bearing at the inner end, and then a four-point ball bearing, which acts as a thrust bearing both ways, and also as a support for the shaft. At the outer end is a metallic packing that also acts as a bearing, and at the same time prevents the lubricating oil from running out of the machine. The motor and shaft run in a bath of oil.

A grip handle is placed in line with the grinding spindle, and the outside of the housing of spindle will also serve as a handle. Mandrels of any suitable length or shape may be attached to the grinding spindle for driving emery wheels, soft polishing wheels, or discs.

This machine is designated as The Thor Pneumatic Grinder No. 7.

CASE HARDENING.—A new German process of case hardening is claimed to give results superior to any hitherto obtained. It is said that a piece weighing 400 pounds can be hardened 0.040 inch deep, and so hard that no steel will cut it, though it may be welded. The work to be hardened is heated in bone dust powder to which is added ¾ pound of yellow prussiate, ½ pound of cyanide of potasium, and one pound of phosphorus. It is heated to a very high temperature in a closed box.—*Machinery.*

PERSONALS.

Mr. George M. Basford has been appointed assistant to the president of the American Locomotive Company.

Mr. J. H. Green has been appointed master mechanic of the Norfolk & Southern R. R., with headquarters at New Bern, N. C.

Mr. N. N. Boyden, master mechanic of the Southern Railway at Selma, Ala., has been transferred to Birmingham in the same capacity.

Mr. F. M. Steele has been appointed road foreman of engines of the New York Central & Hudson River R. R. at Rochester, N. Y.

Mr. F. P. Roesch, master mechanic of the Southern Railway at Birmingham, Ala., has been transferred to Spencer, N. C., in the same capacity.

Mr. J. S. Coniff has been promoted to the position of road foreman of engines of the east end of the Cumberland division of the Baltimore & Ohio R. R.

Mr. Herbert Riddle has been appointed roundhouse foreman of the Denver & Rio Grande R. R. at Salida, Colo., succeeding Mr. W. C. Chambers, resigned.

Mr. A. L. Schilling has been appointed foreman of the boiler shop of the Colorado Midland Railway at Colorado City, vice Mr. Charles Zeitz, resigned.

Mr. William Miller has been appointed acting superintendent of motive power of the Denver & Rio Grande Railroad, vice Mr. J. R. Groves, resigned.

Mr. P. H. Cosgrave has been appointed general foreman of the car department of the Colorado Midland Railway, with office at Colorado City, Colo.

Mr. W. G. Edmondson, engineer of tests, has been appointed mechanical engineer of the Philadelphia & Reading Ry., succeeding F. F. Gaines, resigned.

Mr. J. H. Dummer has been appointed foreman of the machine shops of the Colorado Midland Railway at Colorado City, Colo.

Mr. D. Anderson has been appointed master mechanic of the Chicago Union Transfer Railway, with office at Clearing, Ill., in place of Mr. E. Owen, resigned.

Mr. W. C. Whittaker has resigned as general foreman of the Colorado City shops of the Colorado Midland Railway, and the office has been abolished.

Mr. T. R. Shanks has been appointed master mechanic of the East Board Top Railroad, with office at Orbisonia, Pa., vice Mr. Edgar Shellabarger, deceased.

Mr. J. J. Dewey, master mechanic of the Cincinnati division of the Erie Railroad, has been transferred to the New York division, with office at Jersey City, N. J.

Mr. C. James, master mechanic of the Rochester division of the Erie Railroad, has been appointed master mechanic of the Erie division, with office at Galion, Ohio.

Mr. D. Van Riper, general foreman of the Meadville shops of the Erie Railroad, has been appointed master mechanic of the Rochester division, with office at Avon, N. Y.

Mr. F. W. Williams has been appointed master mechanic of the Oklahoma division of the Chicago, Rock Island & Pacific Ry., vice Mr. James McDonough, resigned.

Mr. B. G. Miller, general car foreman of the Atchison, Topeka & Santa Fe Railway at Cleburne, Tex., has resigned to become general car foreman of the El Paso & Southwestern.

Mr. R. Griffith has been appointed master mechanic of the Colorado Midland Railway Company at Colorado City, Colo. The office of superintendent of machinery has been abolished.

Mr. Q. A. Moriarity, general foreman of the Port Jervis shops of the Erie Railroad, has been appointed master mechanic of the Delaware division, with office at Port Jervis.

Mr. George Akans has been appointed master mechanic of the Southern Railway at Selma, Ala.

Mr. Howard Stillman, heretofore engineer of tests of the Southern Pacific Ry., has been appointed mechanical engineer succeeding F. W. Mahl, resigned.

Mr. William Schlafge, master mechanic of the New York division of the Erie Railroad, has been appointed master car builder at Meadville, Pa., succeeding Mr. R. W. Burnett, resigned.

Mr. O. A. Fisher, master mechanic of the Atchison Topeka & Santa Fe Railroad at Chanute, Kan., has been transferred to La Junta, Colo., in a similar capacity, succeeding Mr. R. Smith, resigned.

Mr. F. F. Gaines, heretofore mechanical engineer of the Philadelphia & Reading Railway, has been appointed to the new office of superintendent of motive power of the Central of Georgia Railway.

Mr. W. S. Murrian, master mechanic of the Southern Railroad at Spencer, N. C., has been appointed superintendent of motive power of the middle and western districts, with headquarters at Knoxville, Tenn.

Mr. W. J. Crandall has been promoted to the position of master mechanic of the New York Central & Hudson River R. R. at Syracuse, N. Y., having charge of the territory between Rochester and Syracuse.

Mr. A. Stewart has been appointed general superintendent of motive power and equipment of the Southern Railway, with headquarters at Washington, D. C. The office of mechanical superintendent has been abolished.

Mr. W. A. Tribby has been appointed fuel inspector of the Baltimore & Ohio R. R. and will look after the fuel used on locomotives over the entire system exclusive of the Baltimore & Ohio Southwestern. He will report to Mr. Muhlfeld.

Mr. James Hainen, general master mechanic of the Southern Railway at Greensboro, N. C., has been appointed superintendent of motive power of the northern and eastern districts of the Southern Railway, with office at Greensboro.

Mr. C W. Seddon, superintendent of shops of the Great Northern Railway at Duluth, Minn, has been appointed superintendent of motive power and cars of the Duluth, Missabe & Northern Railway, with headquarters at Proctor, Minn.

Mr. J. A. MacNeill has been appointed chief inspector of the Union Pacific R. R., with office at Omaha, Neb., vice Mr. F. Jerdone, Jr, resigned. He will have charge of inspection of passenger and freight cars, locomotives and all materials entering into their construction. Mr. MacNeill was formerly connected with the Atchison, Topeka & Santa Fe Railway in the inspection department.

Mr. John R. Blakeslee, president of the Ajax Manufacturing Company, Cleveland, Ohio, died November 9 of Bright's disease, aged 63 years. He was born in Winsted, Conn. At the outbreak of the Civil War he enlisted in the Union Army and at the close of the war located for a short time at Indianapolis, after which he went to Youngstown, Ohio, and then to Cleveland, where he engaged in the machinery business, shortly afterward founding the Ajax Manufacturing Company.

Mr. Henry W. Jacobs has been appointed assistant superintendent of motive power of the Atchison, Topeka & Santa Fe Railway. As noted in the article on "Betterment Work on the Santa Fe" in our last issue Mr. Jacobs has had charge of the tool and machinery betterments for the entire system, and has had direct charge of all the betterment work on the Coast Lines. The significance of Mr. Jacobs' appointment is considered editorially on another page of this issue. He was born in 1874, and from 1888 to 1894 was with the Seaton Foundry Company, Atchison, Kansas, as apprentice, machinist, moulder and structural iron worker. Since that time his experience has been as follows: Machinist with the U. S. Gun Shop, Washington, D. C.; marine experience with U. S. Government, testing engines, trial runs, etc.; machine and erecting machinist, with the Sprague Electric Company, R. Hoe and Company, and Crocker & Wheeler; 1899, manager, Vulcan Engineering Company, engaged in repairs and building of stationary and marine machinery; 1900, took up railway work as erecting machinist, K. C. S. J. & C. B. Ry; tool-room foreman, Burlington Railroad; general shop demonstrator, Union Pacific Railroad.

BOOKS.

Immediate Care of the Injured. By Albert S. S. Morrill, M.D. 340 pages. Published by the W. B. Saunders Co., Philadelphia. Price $2.50.

This volume is intended to be useful alike to physicians, nurses and laymen, as well as to serve as a text book for the use of first aid classes. The subject has been presented in as simple language as possible, technical terms being omitted. It is profusely illustrated by both photographs and drawings.

Switchboards. By William Baxter, Jr. 5½ by 8 in., 188 pages. Cloth. Illustrated. Published by the Derry-Collard Company, New York. Price $1.50.

This book discusses the construction, arrangement and wiring of practically all types and sizes of switchboards. It is profusely illustrated with half tones and line drawings. A special section of the book is given up to the subject of switches, which includes circuit breakers, lightning arresters, etc. The matter included covers both direct and alternating current for power, lighting or railway service.

Combustion and Smokeless Furnaces. By Joseph W. Hayes. 6½ by 9½ ins. Cloth. Illustrated. Published by The Hill Publishing Company, 505 Pearl St., New York. Price $1.50.

This book is written for the purpose of putting the owners and engineers of power plants in possession of information so that they may deal intelligently with the smoke abatement problem. The matter throughout is presented in a popular way with no mathematical or chemical symbols beyond the comprehension of the average reader and appears to effectively fulfil the purpose for which it is written.

Proceedings of the National Railroad Master Blacksmiths' Association. Fourteenth Annual Convention, Chicago, 1906. Edited by A. L. Woodworth, Lima, O.

This volume contains the complete reports of committees and individual papers together with the discussion thereon, delivered at the last annual convention. These included committee reports on frogs and crossings, flue welding, classification of work in the shop, annealing and tempering high speed steel, case hardening, piece work, and making of locomotive frames, as well as individual papers on, formulæ for rings; tools and formers for bulldozers; shop discipline; best coal and kind of fires and thermit. A list of the members, standing committees and subjects for next year are also included.

The Walschaert Locomotive Valve Gear. By W. W. Wood. 5 by 7½, cloth, 185 pages, illustrated. Published by the Norman W. Henley Publishing Company, 132 Nassau St., New York. Price, $1.50.

This, so far as we know, is the first book in English which is devoted exclusively to the Walschaert valve gear, and it fills a demand which during the last few months has become very insistent. It is written in a simple, straightforward style, and the mathematical analyses are elementary. The points in discussion are clearly illustrated by numerous plates, both in half-tone and line drawings; two large folding plates that show the position of the valves of both inside or outside admission type, as well as the links and other parts of the gear when the crank is at nine different points in its revolution are especially valuable in making the movement clear. These employ sliding cardboard models, which are contained in a pocket in the cover. The book is divided into four general divisions, as follows: I. Analysis of the gear; II. Designing and erecting the gear; III. Advantages of this gear; IV. Questions and answers relating to the Walschaert valve gear.

The last division contains sixty pertinent questions with full answers on all the features of this type of valve gear, which will be especially valuable to firemen and engineers in preparing for an examination for promotion.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

AIR COMPRESSORS.—The Ingersoll Rand Company, New York, is issuing a catalog, which illustrates and describes in detail the Imperial type 10 air compressors. These compressors are furnished in both steam and power driven types and contain many refinements of details which are clearly illustrated and described in this catalog.

AUTOMATIC VISES.—The Pittsburg Automatic Vise and Tool Company is issuing a small pamphlet which illustrates and briefly points out the special features of different types of automatic double and single swivel vises. These vises are automatic in that the tightening of the jaws upon the piece automatically locks all of the swivels. They are shown in designs which cover practically every conceivable demand.

ELECTRIC LOCOMOTIVES.—The General Electric Company is issuing a paper bound catalog on the subject of electric mine locomotives in which the general structure and many details of several designs of electric mine locomotives recently built are illustrated and carefully described. These locomotives can be obtained in practically any arrangement and pulling capacity. The illustrations show a large number of interesting types at work.

INTER-POLE MOTORS.—The Electro-Dynamic Company, 11 Pine street, New York, are sending out three bulletins, one presents the revised ratings and diagrams of these motors; another contains a reprint of a paper on "Direct Current Motor Design as Influenced by the Use of the Inter-Pole," presented by C. H. Bedell before the American Institute of Electrical Engineers; the third contains reproductions of several letters from users of the Inter-Pole motors.

AIR COMPRESSOR LUBRICATION.—The Joseph Dixon Crucible Company is issuing a pamphlet with the above title, which very thoroughly considers this important subject. The danger of causing an explosion in the cylinders, pipes, or receivers of air compressors when the temperature of compression exceeds the flashing point of the lubricant used is becoming generally recognized. This pamphlet considers the subject and its remedies, showing wherein flake graphite is of value, not only from the standpoint of safety but also of economy.

HUNT-SPILLER IRON.—The Hunt-Spiller Manufacturing Corporation, 383 Dorchester avenue, South Boston, Mass., is issuing a pamphlet which illustrates a small portion of its works and a few of the various castings being made. This iron is of a special quality and tests have shown it to possess a tensile strength of 35,000 lbs. per sq. in. It is very close grained and is said to have exceedingly fine wearing qualities, which makes it particularly desirable for locomotive work. The illustrations show castings for wheel centres, driving boxes, eccentrics and straps, pistons, cylinders, cylinder heads, bushings, etc.

WHAT WE DO.—The Wellman-Seaver-Morgan Company is issuing a pamphlet entitled "What We Do In Iron and Steel Works Equipment, Ore and Coal Handling Machinery, Cranes, Etc.," which briefly mentions the many and diversified kinds of work which this company is prepared to undertake. Illustrations are included showing some of the more important pieces of equipment which have recently been finished. This company is prepared to design and equip complete plants of any type, taking a bulk contract for the work. They also design and build special machinery of practically all kinds.

UNIVERSAL TOOL GRINDER.—Those interested in the grinding and maintenance of lathe and planer tools should make a point of securing this catalog, describing the Gisholt universal tool grinder, published by the Gisholt Machine Company, Madison, Wis. The catalog is a typical Gisholt publication — handsomely illustrated and printed. The first few pages are devoted to a consideration of the matter of eliminating wastes, due to the improvement of tool grinding and maintainance. The remaining part considers the Gisholt system of tool grinding, the correct method of forging the tools and a description of the Gisholt grinder.

FORT WAYNE ELECTRIC WORKS.—This company is issuing a number of bulletins, arranged for binding in a loose leaf binder, which are numbered from 1,082 to 1,085 inclusive. These each illustrate and describe a single apparatus and are on the following subjects: Mutiple alternating current street arc lighting system; type M A and M induction motors; standard switchboard panels for multi-phase generators, and integrating switchboard watt meters.

HAWTHORNE WORKS.—This very attractive pamphlet illustrates and briefly describes the Hawthorne plant of the Western Electric Company which has recently been completed and will be used for the manufacture of heavy power apparatus and switchboards. An interesting part of the description is that devoted to the provisions against the interruption of the work or shutting down of the plant. These include a system of coal storage providing sufficient coal to operate the plant for four months under normal winter condition, and an elaborate system of fire protection and water supply. Some interesting applications of individual motors to machine tools are shown in connection with interior views of the machine shop. The description of the power plant and electrical equipment is also of special interest.

ANNEALING, BRAZING AND MELTING FURNACES.—The Rockwell Engineering Company, 26 Cortlandt Street, New York, is issuing a number of new catalogs descriptive of its products. One of these is a leaflet on the Rockwell annealing and hardening furnaces, using oil or gas fuel. Another is on the Rockwell heating machines for annealing, hardening, tempering or coloring quantities of like pieces of gold, silver, bronze, copper, steel, etc. The third one is a leaflet on the Rockwell brazing furnaces, which are made in several different designs and sizes. Another considers the Rockwell double chamber metal melting furnace, which is arranged so that the two chambers are used alternately and the exhaust heat from the active chamber flows into the other. Another catalog illustrates and describes several types of fuel oil burning appliances and accessories.

PROGRESS REPORTER.—The December issue of the "Progress Reporter" of the Niles-Bement-Pond Company consists of 48 pages, practically all of which are given up to full page illustrations of the machines in use in the machine shops of the Midvale Steel Company. In these shops some of the most interesting work in the country is done, both in regard to the size of the pieces handled as well as to the extreme accuracy necessary. This company does much work for the government in connection with armor plate, guns of all calibres, marine engines, steel castings, etc. The illustrations in this number of the "Reporter" show the machines furnished by the Niles-Bement-Pond Company in operation on many of these very interesting pieces of work. Notable among these might be mentioned a 12 ft. pit planer, which weighs over 500,000 lbs., and will finish the four edges and one face of an armor plate 24 ft. long, 12 ft. wide and 1 ft. thick.

POWER TRANSMITTING MACHINERY.—The George V. Cresson Company, engineers, founders and machinists, of New York and Philadelphia, is issuing a 350 page, cloth bound, 6 x 9½ in. catalog, which is known as "Catalog B" and supersedes all previous issues. This book, in addition to being a most complete and interesting catalog of the products of this company, is also filled with valuable and reliable data on power transmission equipment. Many engineering rules, formulas, and reference tables have been included. The unusually good illustrations of each article are accompanied in every case by listed tables giving the sizes in stock and prices at which each can be obtained. These tables are numbered in heavy bold face type and the complete index at the end of the book permits any desired number being quickly found. A noticeable feature in the catalog is the fact that each separate type or design is shown separately, having its own individual size and price list. The sizes are made comprehensive by means of line drawings with lettered dimensions. This company handles steel shafts of all kinds, shaft collars, flange couplings, clamp couplings, jaw clutches, flexible couplings, shaft bearings and hangers, girder clamps, pillow blocks, pulleys of all descriptions, fly wheels, gear wheels, belt tighteners, crushers, separators, and in fact every appliance connected with power transmitting machinery. The illustrations are from retouched photographs and are printed in tints of two colors. The artistic work in both illustrations and general arrangement of the book is exceptionally good and it will be found to be not only a valuable reference work but also a fitting addition to any book shelf.

Wood Working Machinery.—A 300 page catalog, "B," issued by the "Oliver" Machinery Company, Grand Rapids, Mich., describes in detail their complete line of wood working machinery and supplies. A well arranged index adds greatly to its value as a reference book. In many instances line drawings are introduced in addition to the half tone illustrations in order to make the construction of machine or tool more clear.

Examples of Rapid Milling.—This is a 64 page, handsomely illustrated publication issued by the Cincinnati Milling Machine Company as a supplement to their milling machine catalog. It contains 60 illustrations, showing a great variety of work done on their plain milling machine, each of which is accompanied by data as to the work, the cutters, the size of the cuts and the rate of doing the work. Very valuable to those interested in this class of work.

NOTES.

Electric Controller and Supply Company.—This company is sending to its friends a copy of the painting, "Laurie," done in black and white embossed work.

Dayton Pneumatic Tool Company.—Mr. L. A. Wyman has accepted a position in the sales department of the Dayton Pneumatic Tool Company, with headquarters at Dayton, O.

Adreon & Company.—This company announces that it has established an office at No. 208 Western Union Building, Chicago, which is in charge of Mr. Edwin W. Hodgkins, vice-president of the company.

Canadian Fairbanks Company, Ltd.—Mr. William S. Howe has resigned his position with the S. A. Woods Machine Company after eleven years service, and in January will become connected with the Canadian Fairbanks Company, of Montreal, Winnipeg, Toronto and Vancouver.

Niles-Bement-Pond Company.—The directors of this company have declared a stock dividend of 40 per cent. on the $5,000,000 outstanding common stock, payable January 2 to holders of record on November 30. Of the $3,500,000 additional common stock recently authorized $2,000,000 is to be issued as the above dividend, and the rest is to be sold to present stockholders. It is also reported that the Ridgeway Machine Tool Company, of Ridgeway, Pa., has passed into the control of this company.

The B. F. Sturtevant Company.—This company is installing a complete equipment of the blower system of heating and ventilating in an eighteen-stall roundhouse of the Canadian Pacific Railway, located at Broadview, Sask. The same company is also installing similar outfits in the new car barn of the Philadelphia & Western Railway, at Llanerchy, Pa., which contains over 600,000 cu. ft. of space, and in the car repair shops of the Somerset Railway Co., Oakland, Me.

Electrical Apparatus at the Collinwood Shops.—The electrical apparatus at the Collinwood shops of the Lake Shore & Michigan Southern Railway was described in a series of articles in this journal during the year 1903. A new 300 k. w., 250 volt Crocker-Wheeler generator has recently been added to this equipment. It operates at 150 r.p.m., has 10 poles, and a 13½ in. commutator face. The full load current is 1,200 amperes, the range from no load to full load being free from sparking without adjusting the brushes, and even momentary overloads as high as 75 per cent. are possible without injurious sparking.

The Crocker-Wheeler Ward-Leonard multiple voltage system of speed control is used. This was one of the first shops to use individual motor driven machine tools, about three-eighths of the tools first installed being individually driven by Crocker-Wheeler motors. That the experiment has proved successful is indicated by the fact that a very large percentage of the machines are now driven in this way.

General Electric Company.—This company has made a contract with the Texas Traction Company for the equipment of a 65-mile electric railroad between Dallas and Sherman, Texas. This line will parallel the existing steam line between the two cities and will be one of the longest electric roads in the state. Power will be generated at McKinney, a town about midway on the line. The equipment of the power station includes two 1,000 k.w. Curtis steam turbo-generators. The current will be generated at 2,200 volts and 25 cycles, and stepped up to 19,100 volts for transmission. The three-phase current from each of the generators will be transformed in a set of three 330 k. w. air blast transformers. Six sub-stations will be provided, including one at the main power house and a portable equipment, the latter comprising a special car containing 300 k. w. rotary converters, air blast transformers and suitable switching apparatus for cutting into the transmission system wherever necessary. The permanent substations have similar equipment delivering 600 volts direct current to the line. It is expected that the transmission potential will eventually be at 33,000 volts, and taps will be provided on the transformers with this in view. The rolling equipment and other features follow in general the standard direct current practice of the General Electric Company.

Extension to the West Allis Works of the Allis-Chalmers Company.—The extensions to the West Allis, Milwaukee Works of the Allis-Chalmers Company, which are now approaching completion, will add 861,000 sq. ft. to the plant's present floor area of 652,000 sq. ft., and make the entire plant capable of affording employment to 11,000 persons. This in connection with the other plants of this company will give it facilities for affording employment to a total of 18,000 persons. The extensions being built consist of three machine shops running east and west and parallel to the existing units of which there are three. These new units will be 575 ft. long and two of them 145 ft. wide, while the third is 168 ft. wide. The new erecting shop will run north and south as an extension to the present shop and will be 1,136 ft. by 113 ft. in size. An extension is also being made to the present foundry, which will give it a total length of 994 ft. and a width of 222 ft. Also an extension to the pattern building, which will give it a length of 994 ft. and a width of 119 ft. The work of constructing these extensions involves an expenditure of over three million dollars.

Machine shop No. 4, which is typical of all six units, is constructed to form two principle bays in cross section, the one on the south side of the building being 66 ft. wide and 52 ft. high, and is served by a 50 ton crane. The bay on the north side is 71 ft. wide and 42 ft. high, and has a line of intermediate columns dividing it into two divisions, one of which is 40 ft. wide and is served by a 10 ton crane. A gallery floor covers the north bay and a mezzanine floor for lavatories, coat rooms, etc., is suspended from the gallery floor girders. Three elevators, of the plunger type, are installed for service to the mezzanine floor and gallery. Tracks extend from the south bay running east and west into the erecting shop. Machine shop No. 6 differs from the others in several features, being four stories in height and built around a central court. The two principle four story bays are 53 ft. wide and 72 ft. high, and are connected at both ends by bays of similar height for a width of 32 ft. at one end and 16 ft. at the other. The centre section is roofed over to a height of one story and divided into two bays, each 26 ft. wide. The erecting shop is practically a duplication of the present building in construction, the principle bay being 72 ft. wide and 72 ft. high and served by a 75 ton crane with a 60 ft. lift. The new foundry and pattern buildings are of the same construction as the existing buildings, being of the modern type adapted to these purposes.

The power house equipment, for furnishing power to the works' extensions consists of one 34 and 54 x 42 in. Reynolds vertical cross compound engine, direct connected to a 1,000 k. w. Bullock direct current generator and an Allis-Chalmers cross compound air compressor with air cylinders 18 and 30 x 42 ins., the steam cylinders being of the same size. In the boiler house five Edgemoore tube boilers with a total aggregate horse power of 3,293, and a heating surface of 6,586 sq. ft. each, will replace the present boiler equipment. The new boilers will be operated in connection with Jones under feed stokers. A stack 175 ft. high and 8 ft. inside diameter will furnish natural draft.

The heavy machine tools of various kinds at present installed will be duplicated in the new machine shop units and supplemented by special tools suitable for specific purposes, such as the building of steam turbines, gas engines, etc. Direct current at 250 volts is distributed throughout the works for the operation of motors on machine tools. These motors are largely operated on the Ward-Leonard multiple voltage five-wire system which gives 27 different speeds for each motor. The yards between the various buildings are as completely equipped with cranes as is the interior of the building, and are utilized for storage.